USE OF DISTRACTION AS AN EMOTION REGULATION STRATEGY IN OLD AGE

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Erin Senesac Morgan

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USE OF DISTRACTION AS AN EMOTION REGULATION STRATEGY IN OLD AGE

Approved by:

Dr. Christopher Hertzog, Advisor
School of Psychology
Georgia Institute of Technology

Dr. Audrey Duarte
School of Psychology
Georgia Institute of Technology

Dr. Paul Verhaeghen
School of Psychology
Georgia Institute of Technology

Dr. Derek Isaacowitz
Department of Psychology
Northeastern University

Dr. Michelle Shiota
Department of Psychology
Arizona State University

Date Approved: June 13, 2014

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LIST OF ABBREVIATIONS

OA = older adults

YA = young adults

NA = negative affect

PA = positive affect

PR = positive reappraisal

DR = detached reappraisal

D = distraction

C = control

SUMMARY

Older adults improve in emotional well-being, and this may be a product of changes in motivation to regulate emotions or emotion regulation effectiveness. However, there are cognitive changes in old age that could make regulation harder in some contexts. The current set of studies sought to determine whether there were age-related improvements or deficits in ability to use distraction in two contexts. The first study examined use of distraction in a recovery context and found no age differences in emotional recovery when 1) using spontaneous self-distraction, 2) intentionally self-distracting, and 3) being distracted by another task. There was, however, evidence that the distracting task was the most effective way to recover from the negative induction. There was also some evidence that cognitive changes with age made it more difficult for older adults to limit negative thoughts in certain conditions. The second study contrasted use of distraction, positive reappraisal, and detached reappraisal by looking at success in terms of emotion regulation and impact on a subsequent cognitive task and later memory for the emotional stimuli. No age differences were found in emotion regulation success in this study either, but interesting differences in consequences of the three regulation strategies did emerge.

INTRODUCTION

Age appears to be associated with increased emotional well-being, with many studies reporting changes in self-reported affect, including greater frequency of positive affect or a higher ratio of positive to negative affect (Carstensen et al, 2011; Diehl, Hay, & Berg, 2011; Kessler & Staudinger, 2009; Mroczek & Kolarz, 1998) and reductions of self-reported negative affect with age (Carstensen et al, 2000; Charles et al, 2001; Costa et al, 1987; Gross et al, 1997; Kessler & Staudinger, 2009; Lawton et al, 1992; Pethel & Chen, 2010; Stacey & Gatz, 1991; Windsor & Anstey, 2010). Further, recently researchers have demonstrated that older adults' negative affect decreases more quickly than young adults' in both laboratory studies (Larcom & Isaacowitz, 2009) and experience sampling studies (Carstensen et al, 2000). Changes in emotion regulation are often cited as a major contributor to this change in emotional well-being (Blanchard-Fields, 2007; Scheibe & Carstensen, 2010).

There are several reasons that older adults may improve at emotion regulation. First, their motivations may change, and they may be more likely to prioritize emotion regulation. Socioemotional selectivity theory (SST) suggests that as people age, their future time perspective wanes and they become increasingly aware of the limited time left in life (Carstensen, 2006). Consequently, they begin to prioritize emotional meaning at the expense of information or novelty seeking, which is favored by younger people. One apparent outcome of this change in motivation is a change in motivation to regulate emotions and to control situations to maximize potential for positive emotions and minimize potential for negative emotions. For example, older people appear to favor interacting with smaller groups of close social partners who are more likely to provide emotionally meaningful experiences (Carstensen, 1992, 2006).

Second, older adults may become more effective at emotion regulation due to practice, which may help them to pick more appropriate strategies or use the same strategies more effectively. For example, older adults are more likely to use emotion regulation strategies in contexts where young adults do not and appear to adapt strategy use to the situation (Blanchard-Fields, 2007). Further, older adults are more able to use strategies that are known to be particularly effective, like reappraisal (changing meaning of a negative stimulus to decrease emotional impact) and distraction (John & Gross, 2004; Phillips et al 2008; Charles, Mather, & Carstensen, 2003; Shiota & Levenson, 2009) and self-report using these strategies more frequently (John & Gross, 2004). They are also less likely to use problematic strategies, like suppression of expression, which is associated with a negative physiological profile (John & Gross, 2011). In addition, recently several studies have found that emotion regulation is less disruptive of other ongoing tasks for older adults than young adults (Emery & Hess, 2011; Scheibe & Blanchard-Fields, 2009). It is possible that increased experience with emotion regulation strategies over time leads to relative automation of strategies that are used frequently and successfully (Bargh & Williams, 2007).

Despite the evidence suggesting age-related improvements in emotion-regulation, researchers have also begun to recognize that there may be times when it is difficult for older adults to regulate emotions. Identifying factors that encourage improved emotion regulation and factors that constrain emotion regulation success for older people is vitally important in understanding age-related change in well-being. One potentially interesting emotion regulation strategy to investigate in this context is distraction. Some research is consistent with the idea that older adults may be more capable of using distraction to regulate emotions, at least in some contexts. However, other research would suggest that using distraction to regulate emotions may become more difficult with age and therefore less effective in some contexts. The current studies examined several contexts to determine under what circumstances emotion regulation through distraction may improve, worsen, or stay the same with age.

The introduction will begin with general background on the concept of distraction, first by describing how distraction will be conceptualized in this study in terms of when in the emotion generation process distraction can occur, how intentional it must be on the part of the regulator, and how it relates to other similar constructs. I will also describe the efficacy of distraction as an emotion regulation strategy. Then, I will outline evidence suggesting how the use of distraction may change with age. Brief sections are first devoted to evidence suggesting age related change in spontaneous self-distraction in several contexts and evidence suggesting age-related change in distraction use related to experience using the strategy. Then, a longer section is devoted to the impact of cognitive changes with age and how these changes might impact ability to use distraction to regulate emotions in various contexts.

What is Distraction?

Distraction has been defined in variable ways in the literature. In general, distraction is defined as a type of attentional deployment strategy in which a person impacts their emotions by attending to something neutral or positive, rather than negatively valenced stimuli or thoughts (referred to as "negative stimuli" hereafter). Particular researchers, however, study and conceptualize distraction in slightly different ways, and distraction may involve different processes in different contexts.

Defining Distraction

When does distraction act in the emotion-generation process? For example, distraction can be studied as either an antecedent or response-focused process, as defined by Gross's modal model of emotion regulation. Antecedent-focused regulation occurs when a person stops the generation of an emotion very early in the process, such as by controlling a situation to prevent an emotional experience from occurring at all (Gross & Thompson, 2007). For example, when riding in a glass elevator, a person with a fear of heights may concentrate his attention on a conversation with another passenger. This person would be limiting processing of visual reminders of the fearful stimulus by attending to something else and this would prevent the fear response. Many studies of distraction have defined distraction in this way (Richards & Gross, 2006; Sheppes et al, 2011; Thiruschelvam et al, 2011).

However, emotion regulation (including distraction) can also happen later on in the emotion generation process. In that case, the person tries to regulate emotional responses that are already underway, such as by trying to control facial expressions or calm oneself. Distraction can also occur at this point in the process, when a person can decide to stop attending to lingering thoughts about negative stimuli or to distract themselves from negative emotions they are already experiencing. Research defining distraction in this way is also common (Denson et al, 2011; Nolen-Hoeksema, 1991). However, this could also be viewed as antecedent-focused regulation, in that people may actually just be distracting themselves from internal negative stimuli (lingering memories of a negative event), and this may prevent generation of new negative emotional episodes. Either way, once a negative emotion has been elicited and the environmental elicitor is gone (referred to as after-the-fact later in the paper), people can limit its continuing impact by using distraction. For example, a person who has just had an angry encounter with a friend might distract herself from those emotions by talking to another friend about an upcoming vacation. This person would be discouraging further processing of the emotional encounter by thinking about something else, and negative emotions associated with the encounter would dissipate. In the current study, I examined both types of distraction. Study 1 examined after-the-fact distraction to determine if there are age differences in use of distraction to recover from emotions. Study 2 examined antecedent-focused distraction to measure age differences in effectiveness of distracting oneself early on in the process of encountering emotionally valenced stimuli.

Does distraction have to be intentional? Another quandary in defining distraction is whether distraction must be an intentional process. Many researchers explicitly define distraction as an intentional attempt to draw attention away from an unwanted stimulus or thought by replacing those thoughts with positive or neutral ones (Nolen-Hoeksema, 1991; Richards & Gross, 2006). However, there is also potential for distraction to become an automatically-engaged process that encourages quick, efficient emotion regulation in certain circumstances. Bargh and Williams (2007) argue that particular emotion regulation strategies can become automated over time, if they are used effectively, repeatedly, and consistently in a particular context. As with many practiced actions, that particular emotion regulation strategy becomes activated in that particular context, and activation can occur unintentionally and outside of awareness (Bargh & Williams, 2007). In that case, in situations where particular people habitually, successfully use distraction to regulate emotions, those people may begin to attend to positive and neutral stimuli or ideas and attend away from negative stimuli even without being aware of enacting this strategy. This leaves open the possibility that people use distraction to regulate emotions even when they have no awareness of this fact and cannot report having used any strategy at all. Intentional, controlled distraction and unintentionally, automatically instigated distraction may also vary in how resource demanding they are. Another issue is that people may sometimes be distracted by other tasks, in which case the environment, not the individual, is providing the distraction. Participant-instigated distraction and environmentally-provided distraction may be differentially effective for different groups of people, which will be discussed in more detail later, so examining the differences in these types of distraction is important.

Study 1 and 2 both include conditions where participants were explicitly asked to distract themselves, and intentional distraction was expected. In study 1 there was also a condition that allowed participants to behave spontaneously, and participants could self-distract intentionally or unintentionally (or use other strategies). With this in mind, participants were asked questions about the extent to which they intentionally tried to use a variety of emotion regulation strategies. However, failure to report use of distraction was not be interpreted as failure to use distraction, since use of distraction may happen outside of awareness. Further, study 1 included a condition that asked participants to distract themselves and that could be contrasted to another condition that provides environmental distraction for participants. Age differences in effective use of distraction to regulate emotions may be different based on how distraction is defined (context).

How does distraction relate to suppression and rumination? How distraction relates to other constructs is also unclear and variably defined in the literature. Some researchers define distraction in ways that are akin to suppression, an emotion regulation strategy where people try not to think about emotion eliciting stimuli (Kalish, et al, 2006; Richards & Gross, 2006). Suppression involves trying not to think about an emotion eliciting stimuli, rather than replacing thoughts about the stimuli with something else, but the two constructs tend to be highly related such that items assessing distraction and suppression have been included in the same scale, in at least one study, and this scale had high internal reliability (Richards & Gross, 2006). Other researchers tend to think of rumination and distraction as highly interrelated. Rumination involves repetitive thoughts about negatively valenced experiences or stimuli and is associated with negative affect and depression (Nolen-Hoeksema, 1991). Nolen-Hoeksema and colleagues suggest that distraction can alleviate the negative effects of rumination on mood (Nolen-Hoeksema et al, 2008), and some researchers seem to conceptualize rumination and distraction as opposites. For example, in one study, people who wrote about whatever they wanted following a negative mood induction were categorized as ruminating (if they kept writing about the negative event) or distracting (if they did not write about the negative event; Denson et al, 2011). This operational definition suggests that distraction is the absence of rumination. The interrelatedness of distraction and other constructs poses some problems for people who are trying to measure a specific construct. For example, if people think less about a negatively valenced stimulus in one situation relative to another, it is unclear whether they have 1) distracted themselves from the stimulus, 2) suppressed attention to the stimulus, 3) simply failed to ruminate about the stimulus in one situation (but did in the other), or 4) all of these things in some combination. This current set of studies did not propose to answer this conundrum. Instead, I concentrated on the extent to which people evidenced attending to negative emotional stimuli. Future research will have to begin teasing apart the individual contributions of failure to ruminate, distraction, and thought suppression to the patterns that are observed, but for the purpose of this project, distraction was defined as any process (intentional or otherwise) that leads a person to ignore or limit processing of negative stimuli.

Assessment of distraction in the current project. In this project, there were several ways that distraction was assessed. Compliance with the request to distract was assessed based on several indicators of attention to the stimuli. First, participants who attend to the negative stimuli less should have worse memory for those stimuli later, so memory for the stimuli was assessed in both Study 1 and Study 2. In the first study, I obtained both online and retrospective reports from participants indicating how often they thought about the negative stimuli once it was gone. In addition, participants were asked questions that indicated the extent to which they intentionally tried to distract themselves, although this was not helpful in measuring distraction that may be deployed more automatically. Previous research has also identified distraction by having raters code participants' stream of consciousness writings to further indicate whether they appeared to be distracting themselves, ruminating or reappraising (Denson, et al, 2011), and this was done with the thought content participants report in applicable conditions in study 1. In the first study, questions about intentional distraction were also asked. Also, an eyetracker was used to track eye movements to determine whether participants viewed the pictures differently when they were supposed to be distracting themselves relative to when they were supposed to be paying attention. Less overall time fixating on salient parts of the pictures would be indicative of less attention to the pictures. By combining multiple measures in each study, I was able to get a sense of the degree to which people continued processing negative stimuli in each condition and the degree to which this was done intentionally or incidentally.

Distraction does not appear to be a unitary construct, with distraction necessarily working the same way in all contexts. For that reason, multiple types of distraction were explored in the studies presented here. Study 1 included distraction during recovery from a negative induction whereas study 2 included antecedently-focused distraction. Further, study 1 included distraction that was initiated by the participant and distraction that was encouraged by environmental demands. Because different types of distraction may require different processes, there was a possibility that age differences in successful use of distraction may be different in these different contexts.

Distraction Efficacy

Distraction appears to be a particularly effective strategy for down-regulating negative emotions (Denson et al, 2011; Nolen-Hoeksema, 1991; Nolen-Hoeksema and Morrow, 1993; Sheppes & Meiran, 2007). Not only does distraction lead to decreases in self-reported affect and physiological arousal when enacted immediately upon encountering emotionally valenced stimuli, it also appears to be a particularly effective way of reducing physiological arousal and self-reported affect once an emotional response has already been elicited, and may be quicker and more effective than other strategies (Sheppes & Meiran, 2007; Sheppes, Catran, & Meiran, 2009). Distraction, when utilized at the onset of the emotion eliciting stimuli, decreases brain activity associated with emotional processing and does this earlier than other highly effective strategies, like reappraisal (Thiruchselvam et al, 2011). Distraction can lead to lower reaction to both positively and negatively valenced stimuli that are capable of eliciting an emotional reaction (hereafter referred to as positive or negative stimuli).

Partially, distraction appears to be effective because it prevents emotional processing at the earliest possible point in the emotion generation process, by preventing processing of the stimuli (Gross, 1998). Even other relatively early-acting strategies, like reappraisal, happen at slightly later steps in processing, such as after a stimulus has been processed and evaluated for emotional meaning (Thiruchselvam et al, 2011). In addition, distraction also appears to be minimally resource demanding for young adults, causing very little disruption in a cognitive resource depletion paradigm (to be discussed more later; Sheppes & Meiran, 2008) and is associated with less sympathetic nervous system activation than other strategies (Sheppes, Catran and Meiran, 2009), which has been associated with self-control in past research (Wegner & Gold, 1995).

Effective Use of Distraction in Older Adults

As noted earlier, recent research has suggested that older adults may improve at emotion regulation relative to their younger counterparts (Carstensen, 2006; Charles, 2010; Scheibe & Blanchard-Fields, 2009). However, it is unclear under which circumstances older adults improve, worsen, or maintain emotion regulation abilities. Some research suggests that older adults may be more likely to try to use distraction to regulate emotions and may be able to use distraction more effectively (Blanchard-Fields, 2007; Phillips et al, 2008). Other research provides evidence that older adults may have difficulty using distraction, especially in certain circumstances. I will review evidence for both of these possibilities and then discuss the two studies contained in this dissertation, which examined a variety of situations to determine whether (and when) older adults are actually better at regulating emotions using distraction.

Age-related Change in Self-distraction Use

As noted earlier, older adults may be more motivated to regulate negative emotions, and this may impact their tendency to distract themselves in the service of emotion regulation. In the context of interpersonal problems, older adults appear to use more passive emotion regulation strategies than do young adults, such as distracting themselves from the problem (Birditt & Fingerman, 2005; Coats & Blanchard-Fields, 2008), which may minimize damage to relationships while still helping regulate emotions (Blanchard-Fields, 2007). Other research suggests that older adults pay attention to and process different information than young adults do. For young adults, there is a tendency to attend to and better remember negative information (the negativity bias), possibly because negative information has more survival value (Baumeister, Bratslavsky, & Fickenauer, 2001). Older adults may be more likely to avoid negative information in favor of positive information, ostensibly in the service of emotion regulation (Mather & Carstensen, 2005). This tendency, termed the positivity effect, has been explored in studies of attention and memory. Some studies show reduced negativity effects, such as when older people fail to remember or attend to negative information better than positive (Charles et al, 2003), or even positivity biases, such as when people orient to or remember positive information to a greater extent than negative information (Mather & Carstensen, 2005). According to SST, this change in the processing of emotional information reflects the consequences of age-related changes in motivation. However, changes in use of attentional deployment could also result from decreased capacity to use more sophisticated strategies, like reappraisal (Labouvie-vief, Grühn, & Mouras, 2009), which requires deeper processing of the stimulus to change its meaning into something with a different emotional connotation. Age-related changes in attention to emotional stimuli appear to occur both during emotional events (antecedent-focused distraction) and during the periods after emotional events.

Age-related change in antecedent-focused distraction. The best evidence that older adults are more likely to distract themselves from negative stimuli antecedently comes from research on the positivity effect in attention. In this research, it is found that older adults not only preferentially attend to the positive information that is presented, but also avoid negative information (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Mather & Carstensen, 2003). These studies largely examine visual attention to the stimuli and find that older adults look towards positive and neutral pictures and away from negative pictures. Further, it is clear that older adults can detect negative information, as both young and older adults initially orient toward negative information; however, young adults continue to look at the negative information, but older adults do not (Rosler et al, 2005). Brain studies also appear to confirm that older adults process less negative information as it is presented (Leclerc & Kensinger, 2008) as evidenced by decreased activity of the ventromedial prefrontal cortex, which is implicated in emotional processing. Further, older adults typically exhibit lower amygdala response in reaction to negative stimuli, possibly because they exert top-down control to minimize processing of this type of stimuli (for review see Kensinger & Leclerc, 2009). It is possible that reduced processing of negative information as it is presented reflects increased use of distraction to regulate emotions. Caveats in interpretation of the positivity effect will be discussed momentarily.

Age-related changes in distraction after-the-fact. Older adults may also be more likely to use distraction to regulate emotions after negative stimuli have subsided and an emotional response is underway (such as during recovery from an emotion induction). Research examining continued processing of negative stimuli suggests that older adults may dwell less on negative information after it has been presented. Decreases in continued processing may help older adults maintain (or return to) greater positive affect in the wake of exposure to negative stimuli.

Positivity effects or reduced negativity effects have been found in studies of autobiographical memory (Kennedy et al, 2004; Levine & Bluck, 1997) and memory for pictures and events (Charles, Mather & Carstensen, 2003; Langeslag & Van Strein, 2009). Positivity effects in memory do not necessarily reflect decreased processing of information after-the-fact. Decreases in attention to negative stimuli as they are presented should also impact memory for the stimuli later, as discussed earlier. However, even when older adults have attended equally to negative, neutral, and positive information as it is presented, they still remember less negative information later (Thomas & Hasher, 2006), consistent with having processed it less in the intervening time. Further, sometimes when older adults attend more to negative pictures, they do not display increased memory for negative pictures relative to other pictures (Charles et al, 2003). Further, meta-analyses suggest that positivity effects may be stronger in memory paradigms than in attention paradigms (Murphy & Isaacowitz, 2008), also inconsistent with the positivity bias in memory being the sole result of differences in attention at encoding. Instead, older adults may dwell less on negative information (and more on positive information) in the time between encoding and retrieval. This could result from older adults distracting themselves from negative information by thinking about other things instead. However, older adults may also be less likely to explicitly search for negatively valenced memories, in which case the difference in memory at retrieval may result from retrieval biases rather than differences in processing of the stimuli since encoding.

Not all research examining age-related changes in attention to negative stimuli must be framed in the context of the positivity effect. Other research also suggests that young adults may be more likely to dwell on negative emotional experiences. For example, age is significantly associated with tendency to ruminate, or have unwanted repetitive thoughts about negative emotional experiences (McConatha et al, 1997; McConatha & Huba, 1999; Phillips, Henry, Hosie, & Milne, 2006; Torges et al, 2008). Phillips et al (2006) found that older adults were less likely to report ruminating about anger experiences, including having angry afterthoughts, thoughts of revenge, dwelling on angry memories or having thoughts aimed at understanding the causes of their anger. Older adults also report being less likely to ruminate in general about negative emotions in other studies (McConatha et al, 1997; McConatha & Huba, 1999).

Rumination has been associated with increased negative emotion (Rusting & Nolen-Hoeksema, 1998), failure to emotionally recover following negative emotions (Denson et al, 2011), and depression (Nolen-Hoeksema, Wisco, & Lyubomirsky 2008). Decreases in rumination about events that elicit negative emotions with age are consistent with increased use of distraction. Older adults may distract themselves from negative stimuli and negative emotions, and this may increase their well-being.

On the other hand, older adults may also ruminate less for reasons other than self-distraction. Reduced rumination in many studies could be the result of being distracted by the environment, rather than being more motivated or more capable of self-distraction. This hypothesis will be discussed in a later section. If that is the case, then older adults may ruminate less following negative events only when there is something distracting to grab their attention, but may not ruminate less when they have to initiate the distractions themselves.

Caveats on the positivity effect. It should be noted that age differences in positivity effects are not always found (Emery & Hess, 2008; Grühn, Smith, & Baltes, 2005; Steinmetz, Muscatell, & Kensinger, 2010), and a meta-analysis found few differences in attention to emotional stimuli in memory or attention tasks across age groups (Murphy & Isaacowitz, 2008). Therefore, it is possible that young and older adults do not differentially attend to and process emotional stimuli. If that is the case, then the current study should reveal no age differences in spontaneous tendency to use distraction.

Even if age differences in positivity effects or reduced negativity effects are real, there are important caveats when interpreting these effects in terms of emotion regulation. The positivity effect has been theorized to serve an emotion regulation purpose, and in correlational research has been linked to better emotional outcomes (Isaacowitz et al, 2009; Kennedy et al, 2004). However, direct causal links between positivity effects and emotional outcomes are rarely tested (Isaacowitz & Blanchard-Fields, 2012). A further problem with positivity studies is that they typically involve stimuli that are not likely to elicit strong emotions, and therefore may reflect an information processing bias rather than emotion regulation (Isaacowitz & Blanchard-Fields, 2012). Recently, Isaacowitz & Blanchard-Fields (2012) have emphasized that for researchers to demonstrate that positivity effects serve an emotion regulation purpose, they must use stimuli that elicit emotions and track the relationship of the positivity effect to emotional outcomes. So, even if biases in processing of emotional stimuli exist, it is not clear that these biases actually suggest changes in emotion regulation. The studies reported here examined both attention to stimuli and emotional outcomes to provide clearer evidence that any attentional findings were related to emotional ones.

Improvements Through Experience

Researchers have also increasingly made the argument that older adults are more competent (not just more motivated) emotion regulators in general (Blanchard-Fields, 2007; Charles, 2010) and in using distraction specifically (Phillips et al, 2008). The strength and vulnerability integration (SAVI) model argues that older adults are especially skilled at using antecedent-focused emotion regulation strategies that allow them to avoid negative situations, like using attentional, behavioral, and appraisal strategies (Charles, 2010). Older adults are also more likely to use emotion regulation strategies that terminate exposure to negative events (like withdrawing from situations or withdrawing attention from situations; Charles, 2010). Improvement in ability to use emotion regulation strategies is consistent with the possibility that older adults, through accumulation of experience over a lifetime, have learned how to regulate quite effectively.

Although research on the positivity effect has found some evidence that older adults may be more likely to try to distract themselves from negatively valenced stimuli, the theory suggests that age differences may be due to changes in motivation. Little research has examined age differences in ability to use distraction to regulate emotions when both age groups are motivated to do so. Phillips et al (2008), however, did compare ability to distract in young and older adults and found that older adults were more successful using this strategy. They asked participants to think of something that made them feel good whenever they began to feel upset by a negative film clip. Compared to control conditions, older adults (but not young adults) reported decreased negative affect in the distraction condition, suggesting that older adults may be more capable of creating distractions to regulate emotions. A problem in this study is that older adults in the control condition responded more strongly to the emotion induction, leaving open the possibility that age-related improvement in regulation ability was the result of differences in the control condition rather than the regulation condition. For that reason, future research needs to replicate the finding that older adults are more capable of using distraction to down-regulate emotions (Study 2 addresses this concern). Further, this study demonstrates greater efficacy in antecedent-focused distraction but gives no insight into ability to use distraction in a recovery situation.

Cognitive Consequences and Requirements for Emotion Regulation

Some emotion regulation strategies appear to draw on cognitive resources, such as working memory and selective attention (Green & Malhi, 2006). Given that there are changes in these cognitive resources with age, an important question arises: how do resource declines and other cognitive changes impact ability to regulate emotions for older adults? There are several potential outcomes, which I will discuss momentarily. First, however, I will give more background about the nature of age-related change in cognition.

Relevant age-related changes in cognition. There are several lines of research that posit changes in cognition that might be of concern to researchers examining the ability of older adults to use distraction to regulate emotions. First, older adults appear to decline in cognitive resources such as working memory and selective attention (Salthouse, 1991). For example, they have more difficulty with working memory span tasks (like computation span, listening span, digit and word spans) that require remembering one set of information while simultaneously processing other information (Salthouse, 1991). Declines in working memory and selective attention may reflect general declines in executive control that could underlie age-related change in performance on many other tasks (Engle, 2002).

Second, older adults may have deficits in their ability to inhibit the processing of irrelevant information (Hasher & Zacks, 1988). Deficits in ability to ignore distracters have been found in a variety of tasks. Older adults slow down when reading text that has distracting words inserted into it (Li et al, 1998), are more likely to be led astray by a to-be-ignored prime that is designed to make a remote associates task more difficult (May, 1999), have more difficulty ignoring their own previous responses even once they are told these responses are incorrect (Hasher & Zacks, 1988), and are more likely to later remember information that they were supposed to ignore (Hasher, Lustig, and Zacks, 2007). However, other researchers have questioned the validity of the inhibitory deficit hypothesis, suggesting that effects that appear to be inhibitory deficits in selective attention tasks may actually reflect general slowing (Verhaeghen & Cerella, 2002).

Changes in cognitive resources and the ability to ignore information could have important impact on older adults' ability to enact strategies like distraction. However, the specific ramifications of these cognitive changes are unclear.

Cognitive changes may not matter for distraction. As noted before, it is possible that inhibitory deficits and issues with selective attention are illusory (Verhaeghen & Cerella, 2002), in which case, age differences in regulation may be primarily driven by other factors. However, there does appear to be some sort of age difference in cognitive control resources, even if there is controversy over the actual mechanism for decline (Braver & West, 2008; Verhaeghen, 2012) but changes in cognitive control do not have to mean changes in ability to use distraction.

Distraction may not be a resource demanding strategy. Even if there are age differences in cognitive resources, that difference may not impact how people use distraction because distraction may not draw on those resources. In young adults, research suggests that emotion regulation via distraction requires minimal self-control (Schmeichel, Vohs, & Baumeister, 2003). Self-control is a process that draws on cognitive resources to "restrain or override one response, thereby making a different response possible" (Baumeister, Vohs, & Tice, 2007, pp. 351). Self-control-requiring tasks include tasks that require working memory and attention, like the multi-source interference task (a task combining Stroop and Simon effects; Shamosh and Gray, 2007), but not tasks like general knowledge tests or recall of nonsense syllables (Schmeichel et al, 2003).

Baumeister and colleagues posit that self-control draws on a limited resource that is depleted with use. Once this resource is depleted, self-control is temporarily unavailable for subsequent self-control tasks (Baumeister, Vohs, & Tice, 2007;

Schmeichel, Vohs, & Baumeister, 2003). Consequently, performance on the subsequent self-control task suffers. This performance decrement is called the depletion effect. Baumeister suggests that the limited resource underlying self-control could be blood glucose, which is necessary for the brain to engage in cognitive control. When participants engage in self-control tasks, blood glucose decreases significantly and performance on subsequent self-control tasks decreases. However, if an experimenter artificially increases blood glucose in a participant following a self-control task, depletion effects can be eliminated (Gailliot & Baumeister, 2007). Other researchers, however, posit other underlying limited resources (Hagger, Wood, Stiff, & Chatzisarantis, 2010).

Suppression of emotional expression and regulation of internal emotional experience cause deficits on subsequent self-regulation tasks, suggesting that these two forms of emotion regulation require self-control (Dillon, Ritchey, Johnson, & LaBar, 2007; Galliot et al., 2006; Schmeichel et al, 2003; Shamosh et al, 2007). However, regulation of emotions via distraction does not cause depletion effects for young adults (Sheppes & Meiran, 2008), and this is true even when distraction is not enacted until partway through stimulus presentation. Further, certain physiological correlates of inhibitory self-control (trying to avoid a strong response or thought) do not increase with distraction, although they do increase with other strategies (Sheppes, Catran, & Meiran, 2009), which may indicate that distraction has relatively low resource requirements. Self-control requirements of distraction have not been tested for older adults, but it is possible that distraction does not require self-control (which relies on cognitive resources), and therefore does not decline with age as cognitive resources decline.

Age-related reduction in resource requirements for distraction. Even if future research suggested that distraction calls for cognitive resources for young adults, older adults may still maintain preserved ability to use distraction. Recently Scheibe and

Blanchard-Fields (2009) suggested that older adults may regulate emotions more efficiently (i.e. using fewer resources), though they did not specifically examine distraction as a strategy. Scheibe and Blanchard-Fields (2009) found that young adults, but not older adults, were disrupted in a dual-task paradigm by trying to regulate negative emotions. Emery and Hess (2010) also found that young adults, but not older adults, were disrupted by an emotion suppression task. Further, Senesac and Blanchard-Fields (2012) found evidence that young adults, but not older adults, were depleted by emotion regulation and performed more poorly on a subsequent task if they had previously regulated emotion.

Decreases in magnitude of cognitive resources (such as attention or cognitive control) devoted to emotion regulation may also extend to distraction. Bargh and Williams (2007) suggest, as previously described, that frequently successfully used emotion regulation strategies will become relatively automated with practice. If older adults are more motivated to try to use distraction, then distraction may become relatively automated for them, and age-related declines in cognitive resources may not impact ability to regulate emotions. However, older adults may also become more efficient at regulating emotions because they choose different, more efficient strategies that are easier for them to use (as discussed in: Emery & Hess, 2010; Scheibe & Blanchard-Fields, 2009; Senesac & Scheibe, 2014). In that case, specific strategies may not become more automated, and age-related declines may be seen in ability to implement strategies that are highly demanding of resources.

Cognitive changes may cause problems with distraction. Although research with young adults suggests that distraction is not a particularly resource-demanding regulation strategy, some research does suggest that distraction is resource-demanding for older adults and that they may have difficulties with it in some contexts. Changes in cognitive resources or the ability to ignore stimuli might interfere with the ability of older adults to distract themselves, especially when resources are otherwise in high demand.

Older adults have difficulty ignoring emotional information. Changes in ability to ignore irrelevant information (as posited by the inhibition deficit hypothesis) may make distraction harder for older adults compared to young adults. In situations when older adults are recovering after an emotion induction, difficulty ignoring unwanted information (such as the negative stimuli they encountered earlier) may cause difficulties in orienting attention away from negative emotions or thoughts. Similarly, when older adults are trying to enact distraction as they are encountering stimuli, they may have difficulty orienting away from the negative stimuli. Consequently, older adults may continue processing or thinking about negative stimuli even when trying to ignore it, and this may interfere with down-regulation of negative emotions. Some research supports this suggestion.

As previously detailed, it seems that older adults may have more difficulty ignoring irrelevant information. It also appears that older adults may have more difficulty orienting away from emotional information specifically. Emotional information appears to be preferentially attended to for all age groups (Loftus, Loftus, & Messo, 1987). However, in one study when young adults are encouraged to process other elements in addition to emotion, they appear capable of doing this, and memory for those non-emotional elements of a stimulus improves (Kensinger, Piguet, Krendl, & Corkin, 2005). Older adults did not appear to alter attention to emotional parts of stimuli, even when instructed to do so, and this may reflect difficulty disengaging from emotionally valenced stimuli in some cases (Kensinger et al 2005). If this is the case, then older adults may find emotion regulation strategies such as distraction that require orienting away from negative stimuli to be quite difficult. They may perform better when they are able to orient towards this attention-capturing information, but use a different strategy such as reappraisal, which allows attention to the stimuli, to accomplish emotion regulation.

Older adults CAN orient away from negative information, but it may require greater resources. However, other research suggests that older adults can successfully orient away from emotional information, especially negatively valenced emotional information. Especially in the context of positivity effect research, many studies find evidence that older adults DO look toward negative information less than young adults and later remember negative information less well (Allard & Isaacowitz, 2008; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Thomas & Hasher 2006). It is possible that older adults *can* orient away from emotional information, but that it is more difficult for them because of changes in ability to ignore distractors.

To compensate for cognitive changes, older adults may have to devote greater resources to distraction, compared to young adults, which is consistent with research that suggests that distraction is resource demanding for older (but not younger) adults. If the positivity effect is an emotion regulation strategy and consistent with distraction, then some research suggests distraction is resource demanding. Mather and Knight (2005) and Knight et al. (2007) determined that older adults under divided attention not only fail to exhibit the positivity effect, they actually demonstrate an increased negativity effect. They posited that this effect is the result of a two part process responsible for the positivity effect: a relatively effortless process that monitors for the to-be-ignored negative information and a more effortful process that actually orients attention away from the negative stimuli. When attention is divided, older adults can successfully monitor for negative information, but cannot complete the more resource demanding second process, and consequently end up paying more attention to negative stimuli. Further, older adults higher in executive functioning are more likely to experience positive mood when displaying positivity effects than are older adults who are lower in executive functioning. Lower functioning older adults may display positivity effects, but this effect does not result in better mood (Isaacowitz et al, 2009). The positivity effect, therefore, may be possible when other resource demands are low, but may be too resource demanding in situations where resources are being taxed by other tasks.

Other researchers, however, have demonstrated positivity effects even when older adults are under divided attention (Allard & Isaacowitz, 2008; Thomas & Hasher, 2006). Thomas and Hasher (2006) asked participants to perform a number parity task while being exposed to emotional words and found that older adults only reliably remembered positive words but not negative words, despite being distracted by another task at the time of encoding. Similarly, Allard and Isaacowitz (2008) demonstrated a positivity effect in attention to images while older adults were simultaneously engaged in an auditory lexical decision task. One possible cause of differences between Allard and Isaacowitz's and Knight and Mather's studies is that the task performed in Allard and Isaacowitz's study required lexical decisions at the onset of each stimulus and not throughout presentation. Consequently, older adults may have used cognitive control resources to enact positivity preferences, but the requirements may not have been so extensive that they were impossible under divided attention.

Therefore, there is some evidence that orienting away from negative stimuli requires cognitive resources for older adults in some tasks. This implies that orienting away from negative stimuli/toward positive stimuli might be possible for older adults when resource requirements are low but more difficult when resource requirements are high, although these studies have examined cognitive control requirements in attentional preferences and have not examined the relationship to emotion regulation success itself. Therefore, it is unclear how cognitive loads impact emotion regulation success itself. In addition, although research demonstrates that the positivity effect sometimes requires cognitive resources, it is unclear whether distraction in general requires cognitive resources.

Cognitive changes may assist in distraction. In some circumstances, older adults may serendipitously benefit emotionally from reduced resources and difficulty ignoring irrelevant information, especially after-the-fact. Being distracted by another ongoing task is an effective way of regulating emotions for young adults (Denson et al, 2011), who are otherwise likely to continue ruminating about negative events. In studies where older adults recover from emotion inductions more quickly than young adults (Larcom & Isaacowitz, 2009; Carstensen et al, 2000), older adults may not have been more likely to try to regulate emotions or more effective at regulating emotions. Instead, they may simply have been more distracted by other stimuli, compared to young adults. For example, Carstensen et al (2000) found in an experience sampling study that negative emotions were less stable for older adults (less likely to be present at a later time point). What is unclear, however, is what activities people were engaged in during the time period between questionnaires. Older adults may have been engaged in activities that distracted them from their emotional experiences. Similarly, Larcom and Isaacowitz (2009) provided participants with another task to do between emotion ratings, and it is possible that this task was more distracting for older adults, leading to a better emotional outcome after 20 minutes.

Two types of research are consistent with the suggestion that changes in recovery may be driven by task engagement. First, inhibition deficits might cause older adults to have difficulty ignoring currently ongoing tasks, even if they would otherwise continue to dwell on past negative emotional experiences (as young adults often do). Difficulty maintaining negative information in the face of other incoming stimuli would help older adults to return to more positive affect, even without them trying to regulate emotions at all. Similarly, reduced cognitive control resources could also limit the ability of an older adult to both do a current task and think back about what they were doing before, which is consistent with Smallwood and Schooler (2006)'s mindwandering research. Smallwood and colleagues (2002) demonstrate that people mindwander, or think about things other than the current task, more when tasks are less resource demanding (such as requiring less attention or working memory). They argue that when tasks are more resource consuming, people have fewer resources left over to think about other things. By extension, if two people are doing a task that requires equivalent resources, the person who starts with fewer resources should be less able to mindwander. Older adults appear to have reduced resources (Salthouse, 1991), and therefore should mindwander less, which is supported by data from Jackson and Balota (2011; 2012), Giambra (1989), and McVay and colleagues (2013). Based on this theory of mind wandering, older adults should be less likely to have resources available for thinking about emotion eliciting stimuli that is not currently present, and this could impact their emotional recovery. Older adults might recover faster or more effectively than young adults in situations where they have to devote most of their cognitive resources to another task. In study 1, participants were given a task that was somewhat resource-demanding, so that environmentally-provided distraction could be examined further.

However, other perspectives on mindwandering would make the opposite argument. McVay & Kane (2010) argue that mindwandering is a default state that people must suppress when they need to do other tasks. From this perspective, people who have greater cognitive resources are more able to suppress the mindwandering tendency, which allows them to perform more successfully on tasks requiring attention. In this case, people with greater cognitive resources should mindwander *less* than those with fewer resources. For recovery from emotion inductions, this would mean that older adults, who have fewer resources, may be less able to resist the tendency to think back about negative events when they are engaged in other tasks, and therefore may benefit from distracting tasks to a lesser degree than young adults. Inhibition deficits could also be consistent with difficulty moving attention from one task to another. Difficulty inhibiting irrelevant information includes difficulty with removing previously relevant but no longer relevant information from working memory. If this is the case, then older adults may have more trouble ignoring previously viewed negative information in favor of a current task, and this may lessen the positive impact that distracting tasks can have on emotion. Although it seems likely that age-related changes in resources and inhibition could play a role in how people recover from emotion inductions, it is not clear whether the influence of this change would aid or hinder emotional recovery in older people.

Impact of cognitive changes may depend on distraction context. It is also possible that the impact of cognitive changes (and whether distraction is even resource-consuming) will depend on the distraction context. For example, after-the-fact distraction may be easier (or less demanding) than antecedent-focused distraction. In after-the-fact distraction, participants no longer have valenced stimuli directly in front of them to capture and retain their attention. During presentation of stimuli, distraction may be particularly difficult because positive and negative stimuli appear to grab attention (Kensinger et al 2005). Trying to ignore something that is naturally salient may be more difficult than putting aside thoughts about a stimulus that is no longer present. For example, children who are asked to delay eating a cookie are able to wait longer if the cookie is covered, supposedly because this naturally limits the degree of thinking about the cookie compared to when the cookie is still visible (Mischel, Ebbesen & Zeiss, 1972). Distracting oneself in these two separate contexts, therefore, may be differentially dependent on the cognitive resources that appear to change with age, so aging may differentially impact ability to self-distract in these two contexts.

Further, as suggested before, distraction provided by the environment (such as when one is recovering from an induction and doing another task) and self-initiated distraction may have different relationships with cognitive resources. Smallwood suggests that mindwandering (such as thinking back on previous information) is more difficult for people with fewer resources, such as older adults, which would suggest that older adults may be more easily distracted from negative events during recovery. However, higher cognitive resources may be an asset during antecedent-focused distraction, which would predict that older adults may have difficulty with antecedent-focused distraction. It is important to examine both types of distraction, rather than generalize from one to the other.

The question remains: how difficult is using distraction to regulate emotions for older adults? Is it more or less demanding for older adults than younger adults, or is it relatively effortless for both groups? Studies 1 and 2 included different contexts and examined the relationship between age-related cognitive resource-decline and distraction success in different ways. Understanding the cognitive costs of self-distraction as an emotion regulation strategy will give us insight into when this strategy might be difficult or ineffective for older adults. The first study examined the relationship between cognitive resources and functioning and emotional outcomes during emotional recovery in several different conditions. The second study examined the depletion costs and memory outcomes associated with online distraction (distraction in-the-moment) to determine whether there are age differences in the costs of distraction. If distraction is particularly demanding for older adults, it seems likely that distraction would be impossible for older adults under certain circumstances, such as when other resource demands were high or when the negative stimuli are particularly attention grabbing and difficult to ignore. In contrast to Study 1, Study 2 used a paradigm in which participants must distract themselves from the negative stimuli when they were present, as this seems to be the most likely time that cognitive control requirements would be high.

Memory costs of distraction. Research has demonstrated that distracting oneself from an emotional event impairs memory for the event (e.g., Richards & Gross, 2006; Sheppes & Meiran, 2008). For example, Richards and Gross (2006) demonstrated that participants asked to distract themselves while watching a negative film clip later remembered less information about the film clip than a control group who just watched it. Further, the amount of effort put into distracting oneself correlated with memory success, such that participants who put more effort into distracting themselves had worse memory for the clip. This is unsurprising, given that distraction prevents processing of the emotional event. It is feasible, therefore, that distraction could be a problematic strategy in situations where processing is important, such as when remembering the stimulus later may be crucial.

In addition, distraction may prevent processing that could help people to acclimate to a negative stimulus. Thiruchselvam et al (2011) asked participants to view negative images while either distracting themselves or reappraising the images. They measured the late positive potential (LPP), an EEG signal sensitive to the processing of emotionally arousing stimuli. They found that both of these strategies reduced the LPP, although distraction impacted the LPP earlier than reappraisal, consistent with distraction acting earlier in the processing of the negative stimuli. When they re-exposed participants to the same images, participants who had distracted themselves on a particular stimulus had larger LPPs than those who had reappraised. They suggest that participants who reappraised the stimuli have a more neutral interpretation of the stimuli during the second encounter, but those who distracted themselves still found the stimuli to be emotionally arousing. Reappraisal is associated with decreases in emotional response with re-exposure in both self-report studies (Wilson & Gilbert, 2008) and brain studies examining amygdala reactivity (Walter et al, 2009). The authors suggest that for stimuli that will be repeatedly encountered, reappraisal may be a more adaptive emotion regulation strategy than distraction because it offers a long-term emotion regulation solution. Distraction, on the other hand, is highly effective and impacts responding at an earlier time point, but offers no benefits with repeated encounters. Distraction, therefore, may be a better choice when a stimulus is unlikely to repeat, but may have downstream consequences when used for a recurring stimulus. Regardless, distraction will interfere with memory for an event, which may be a problem if remembering the event is important.

The Present Studies

So far, I have discussed several ways in which older and younger adults may differ in use of distraction in ways that could improve emotional outcomes for older adults. First, older adults appear to be more likely to distract themselves from negative information and avoid processing it or ruminating about it after-the-fact. Second, older adults may be more effective at distracting themselves, even when both age groups are equivalently motivated. And finally, in certain circumstances such as when recovering after an emotion induction, older adults may benefit from being more easily distracted away from negative stimuli, which might prevent them from ruminating about them. However, for each of these possible improvements, there is also potential for age-related decline or no age-related change. Apparent increase in use of distraction could be a product of simply being more distractible, rather than a change in strategy use, in which case older adults may not spontaneously use distraction more than young adults. Older adults may not be more effective at distracting themselves, as this has received limited support in the literature, and in fact may have more trouble due to limited cognitive resources. And older adults may actually be less benefited by environmental distraction compared to younger adults. It is important to look at these situations to determine in which situations older adults improve at using distraction and in which situations there may be no age-related change or age-related decline. The current studies were designed to test age differences in several aspects of distraction. The first study examined 1) use of distraction in a recovery paradigm under several types of instruction and 2) whether this accounted for age differences in emotion regulation success. The second study attempted to examine 1) depletion and memory costs associated with distraction and 2) compared these costs to the costs of another set of regulation strategies that allows attention to the negative stimuli.

Study 1 used a paradigm where participants were recovering from a negative mood induction, which allowed examination of the extent to which 1) older adults benefited from environmentally provided distractions compared to young adults, 2) older adults created their own self-distractions to a greater extent than young adults (consistent with differential motivations), and 3) older adults more effectively distracted themselves when asked to do so. Study 1 also provided a context to examine the impact of cognitive control resources on successful use of distraction in emotion regulation. If self-distraction requires cognitive control, for example, and older adults differ in magnitude of cognitive control resources, then some older adults should be more capable of self-distraction than others. In the context of Study 1, I expected that older adults who were asked to distract themselves may be more successful if they have greater cognitive control. On the other hand, older adults with low cognitive control may benefit just as much (or possibly more) from the condition in which a distraction was provided and did not have to be the result of self-initiated control of attention.

Study 2 utilized a paradigm in which participants self-distracted during the presentation of negative stimuli, because this seems like the context where self-distraction would be most difficult and therefore most likely to require cognitive control. In addition, study 2 used a depletion paradigm to examine costs of distraction for each age group and compared these costs to another effective regulation strategy, reappraisal. Further, memory for negative stimuli was examined. By looking at the costs associated with distraction, I hoped to clarify whether it is a resource demanding strategy for older adults, and by extension, whether there were situations where regulating emotion through distraction would be difficult or impossible for older people.

A further intended contribution of both studies was the use of psychophysiological indices of emotional arousal in addition to self-reports to gauge emotion regulation success, though this attempt met with limited success. Self-reports can be prone to experimental demand characteristics and may reflect an individual's self-concept. These variables are less likely to influence physiologically measured arousal, which would be more difficult for participants to control without actually regulating emotions. In addition, repeatedly asking someone to report on their emotions (such as during a recovery paradigm) could impact emotion regulation by drawing attention to one's emotional state. When participants attend to and analyze their own emotions, their negative emotions tend to decrease. By unobtrusively measuring emotional arousal during recovery, I attempted to reduce the risk of interfering with participants' emotional reactions.

The use of physiological measures in this study was somewhat exploratory. The studies here combined manipulations of both emotions and cognitive demands, so prediction of the precise patterns of physiological activity was complicated. How the cognitive and emotional factors in the study may interact was unclear because typically, only one is manipulated at a time and both lead to sympathetic nervous system arousal. To increase the chances of having interpretable results, I included measures that are selectively sensitive to different neurotransmitters involved in sympathetic nervous system activity. The three neurotransmitter types of interest are alpha-adrenergic, beta-adrenergic, and cholinergic, each of which have receptor sites in different parts of the body, meaning that each of these neurotransmitters can act separately on different areas or systems. Therefore, there are some physiological measures that are primarily influenced by only one of these neurotransmitters and that may selectively respond in particular types of situations. Total peripheral resistance (TPR) is a vascular measure that is sensitive to alpha-adrenergic influence only and appears to be impacted when people are stressed, but not when they are merely cognitively challenged but not distressed (Seery, 2012; Tomaka, et al, 1993; Tomaka et al, 1997). Pre-ejection period (PEP) is sensitive to beta-adrenergic influence and appears to be related to general arousal and to cognitive engagement, though its meaning is not always clear. Skin conductance (in this case, skin conductance response count and skin conductance level) is selectively sensitive to cholinergic influence and is particularly informative in detecting orienting responses, which can be helpful when researchers are trying to determine whether someone is paying attention to stimuli. Inter-beat interval (IBI) should be sensitive to overall SNS arousal and is multiply determined. In addition, respiratory sinus arrhythmia (RSA) provides a measure of parasympathetic activity.

Although prior research has often examined cognitive and emotional arousal separately, specific outcomes in this study were hard to predict because both things were manipulated at once. However, there was some research to suggest possible outcomes. For example, in trying to tease apart arousal that is due to cognitive engagement and arousal due to emotion, some useful research on challenge and threat appraisals may assist in interpretations. This line of research suggests that when people are motivated to perform and engaged in a task, they can make either a challenge or threat appraisal about the task, and these two types of appraisals have different physiological correlates (Seery, 2012; Tomaka, et al, 1993; Tomaka et al, 1997). Challenge appraisals occur when the individual feels they have the resources to deal with the given task. These types of appraisals are accompanied by low distress. Threat appraisals occur when the individual feels they do not have the resources to meet task demands, and this type of appraisal is associated with higher distress. Whereas both types of appraisal are associated with increased heart rate, challenge appraisals are associated with decreased TPR whereas threat appraisals are accompanied with increased TPR. TPR appears to be primarily associated with the stress reaction, whereas heart rate may be sensitive to cognitive engagement. In the studies reported here, this delineation was expected to be useful for two reasons. First, in tracking emotional recovery in study 1, TPR was expected to index emotional recovery even if heart rate (or PEP) was still indicating arousal associated with cognitive engagement in the ongoing task. Second, in study 2, people who were successfully reappraising negative stimuli (to be discussed further later) were expected to have physiological profiles similar to a challenge response, and those who were unsuccessful were expected have profiles more similar to a threat response.

Further complicating the picture is the fact that different emotions appear to have different physiological profiles. For example, disgust is associated with heart rate deceleration, whereas fear, anger, and sadness are associated with heart rate acceleration (Levenson, 1992). Because different emotions may manifest in different ways, it was difficult to predict a priori what the physiological responses of participants would be. Unfortunately, the complex nature of the physiological variables did interfere with their interpretability in both studies, but some useful information was gleaned from them.

STUDY 1

The goal of study 1 was to begin to explore under what conditions older adults evidence more (or less) effective use of distraction to regulate emotions, specifically in a recovery context. As reviewed, various lines of research suggest reasons that emotion regulation through distraction may improve or become less effective with age. First, although it seems possible that older adults are more easily distracted by other events and that this helps them recover, this hypothesis has never been tested. It is possible that older adults' reduced cognitive resources are a liability that makes it difficult for them to benefit from external distracters to the same degree as young adults. Second, although one study has demonstrated that older adults are more able to self-distract (Phillips et al, 2008), it 1) did not look at self-distraction during recovery (instead, it looked at online self-distraction) and 2) has not been conceptually replicated. Further, older adults may have more difficulty self-distracting compared to young adults because they appear to have more difficulty ignoring information. Finally, although studies on the positivity effect and age-related change in rumination suggest that older adults may be more likely to distract themselves in the service of emotional recovery, there are some problems with these studies that need to be addressed. First, the positivity effect may not reflect emotion regulation, but rather an information processing bias (Isaacowitz & Blanchard-Fields, 2012). Second, rumination may decrease with age because older adults may be more easily distractible, rather than because older adults are more likely to distract themselves from negative thoughts. Therefore, it is important to determine whether older adults distract themselves in a situation where environmental distractions are not provided and where emotion regulation success can be clearly demonstrated and related to the degree of attention to the negative stimuli. In addition, decreased rumination in older adults is often found in the context of self-reports after-the-fact. It would be beneficial to demonstrate reduced rumination in older adults by tracking rumination as it is occurring, to confirm that decreases in rumination on negative events are not a product of self-concept or another factor that could bias self-reports.

Study 1 was designed to evaluate outcomes in situations that seem like good candidates for determining whether differential motivation, greater practice, and greater distractibility do result in different emotional outcomes for older and younger adults. To this end, participants viewed negative pictures and then some participants were allowed to think about whatever they like (stream of consciousness—with no regulation instructions), others were specifically asked to try to distract themselves while otherwise thinking about whatever they like (stream of consciousness—instructed), and others were distracted by a cognitive task (FAS fluency task). I measured physiological recovery, self-reported recovery, and negative mindwandering (rumination) during these three tasks (the recovery period). Comparing age differences in these conditions should begin to elucidate where there may be age-related improvements and deficits in emotional recovery.

This study also provided an opportunity to address the relationship between distraction and cognitive control. I planned to examine whether cognitive resources, in this case working memory and selective attention, appeared to be related to the ability to regulate emotions using distraction. Working memory capacity and selective attention were selected because they are related to how well people can control what information is attended to and what information is ignored (Engle, 2002), which seems to be the crux of regulating emotion through distraction. In the analyses, I used structural equation modeling to examine whether cognitive resources predicted emotion regulation success in specific conditions.

Hypotheses

In all hypotheses, more successful use of distraction will be defined by quicker or more complete reduction in negative emotions/arousal (or improvement in positive emotions), lower negative mindwandering, and decreased memory for the negative stimuli. Many of the hypotheses for this study are exploratory, and multiple outcomes could be expected based on prior research. Therefore, many hypotheses have multiple, sometimes contrary hypotheses within them.

Hypothesis 1

Because distraction from negative stimuli helps people recover from negative emotions, participants who were given a distracting task were expected to evidence down-regulation of negative emotion. Assuming that environmental distractions aid in quicker or more effective recovery from negative mood inductions for older adults compared to younger adults, older adults who are being distracted by a task were expected to recover to baseline more quickly than young adults. It was also possible, however, that environmental distractions would be less effective for older adults, if they are more easily captured by the negative emotional stimuli that they have just seen, which would result in slower or less complete reductions in negative emotion, greater negative mindwandering, and greater memory for the negative stimuli.

Hypothesis 2

Much evidence suggests that older adults are more motivated to maintain positive emotional experiences, so older adults may be more motivated to use strategies like self-distraction to recover from emotions. Hence, older adults were expected to think less about the negative pictures, improve more (or more quickly) in emotional outcomes compared to young adults, and have worse memory for the negative stimuli, when neither group was provided with a distraction. However, some research fails to find differences in attention to negative stimuli, and there is a possibility that differences that are found are driven by factors other than motivation (such as changes in distractibility). Further, rumination research, which suggests older adults have fewer perseverative thoughts about negative experiences, often uses retrospective reports, which may be biased by self-concept. It was possible, therefore, that evidence suggesting older adults spontaneously use distraction more so than young adults is contaminated by other factors, and in which case young and older were expected to be equally likely to spontaneously use distraction in this study.

Hypothesis 3

Both groups were expected to manifest self-distraction (evidenced in reduced emotional arousal and self-reported negative affect, reduced negative mindwandering, and reduced memory for the stimuli) to some degree when asked to do so by the experimenter. Young adults, however, were expected to improve significantly in emotional outcome and have greater evidence of self-distraction when instructed compared to when they are allowed to think about whatever they like. Older adults were expected to evidence less improvement from the self-directed condition, since they were expected to be motivated to regulate in both conditions. Further, even when instructed to regulate emotions, it was expected that older adults may recover more quickly than young adults, if they are simply more effective at distraction. It was also possible, however, that older adults would have more difficulty distracting themselves to regulate emotions, in which case, when both age groups were motivated to regulate, young adults were expected to regulate more effectively.

Hypothesis 4

Finally, cognitive resources may influence ability to implement distraction as an emotion regulation strategy. As discussed earlier, it is unclear, from prior research, whether participants with higher cognitive resources would benefit more or less from having an externally governed environmental distractor task, so it was unclear how cognitive resources would predict emotion regulation in this condition (FAS). Further, when participants were asked to self-distract, if distraction is not resource-demanding (as YA research suggests), it was expected that there may be no relationship between resources and distraction success. However, if distraction is resource-demanding, then it was expected that there should be a relationship between working memory/selective attention and ability to distract. This was expected to be especially true for whichever age group regulated less efficiently (must use greater resources to use distraction). In all conditions, degree of negative mindwandering (rumination) during recovery was expected to mediate the impact of cognitive resources on emotional outcomes.

Hypothesis 5.

It was expected that older and younger adults would report intentionally trying to use distraction when they were instructed to do so, but it was unclear whether they would report intentional distraction when they were left to think about whatever they wished, or if distraction in that situation would not be an intentional process.

Methods

Participants

The study included 105 older adults (aged 60-85) and 133 young adults (aged 18-30). Some participants could not be used for the study (dropped out after session 1, had computer issues affecting their data, etc). In study 1, ultimately 116 young adults and 92 older adults were included in analysis. Older adults were recruited from the

Atlanta community and compensated $50-65 for their participation. Most younger adults were recruited from the GT participant pool and compensated with Experimetrix credit, but a few were recruited from the Atlanta community and compensated with pay.

Materials

Selective attention tasks and working memory tasks. The selective attention tasks were selected to be theoretically consistent with resistance to interference, which is similar to what participants must do to use distraction in which they must inhibit processing of certain pieces of information that are not goal-relevant. Stroop, flanker, and anti-saccade tasks were all demonstrated to load onto the same latent factor, believed to reflect prepotent response inhibition and resistance to distractor interference (Friedman & Miyaki, 2004). Engle and colleagues have also demonstrated that people with lower working memory appear to have more difficulty inhibiting processing of irrelevant information. The R-span, visual arrays and N-back tasks involve working memory.

Stroop task. The color-word Stroop task required participants to name the color of a word while ignoring the content of the word (Stroop, 1935). Sixty incongruent (text color and content do not match), 60 congruent (text color and content match) and neutral (text content is X's) were intermixed and presented on a computer screen one word at a time. The color of the text was red, green, or blue, and participants said the color of the word aloud. A microphone allowed for voice-keyed recording of reaction time and an experimenter recorded accuracy by hand.

Flanker task**.** This task, originally developed by Eriksen and Eriksen (1974), asked participants to name a central letter that was presented with or without distractor letters on either side of it. The flanker task used in this study was based on Friedman and Miyaki (2004). Participants pressed the left hand key if the letter is an H or K and the right hand key if the letter is an S or C. Four trial types were included: letter alone (no noise), letter surrounded by itself, letter surrounded by another letter, but with a compatible response (HHHKHHH), and the letter surrounded by other letters with an incompatible response (CCCKCCC). Participants completed 32 practice trials and 160 trials, 40 of each type. Scoring is discussed in Appendix A.

***Anti-saccade task*.** The anti-saccade task was the same as that used by Hutchison (2007). Participants were asked to identify to a target stimulus (O or P). Prior to the target, an asterisk appeared on the opposite side of the screen (300 ms), and participants were told to look away from the asterisk to the other side of the screen so that they could identify the target that appeared there. After the asterisk, there was a random delay (1,000 to 2,000 ms) before the target appeared for 100 ms and then was replaced by a pattern mask (##) for 5,000 ms. There were 6 practice trials followed by 48 experimental trials.

***R-span*.** The study used the automated version of the Reading span task developed by Unsworth and colleagues (2005). Participants read sentences onscreen and made a judgment about whether the sentence made sense, which they answered with a mouse click. A letter followed each sentence, and participants were asked to remember the letters for a later test. Letter set sizes range from 3 to 7 letters, for a total of 75 letters in the entire test. Participants were given feedback about their accuracy, to ensure they read sentences carefully, and their reading time during practice was used as a reading time limit during test, to help eliminate rehearsal of letters. The test measured absolute R-span (total letters remembered of all perfectly recalled sets), total number correct (total number of letters recalled in the correct position), total errors (both accuracy errors and errors due to running out of time to make a decision about the sentence).

***Visual arrays*.** The visual arrays task was originally designed by Luck & Vogel (1997), but the one described here was used by Shipstead, Redick, Hicks, & Engle (2012). Participants were asked to determine whether one element of a visual array had changed or remains the same. A fixation cross was presented for 1000 ms, followed by a 100 ms blank screen and then 500 ms target array presentation. The target included between four to eight squares, presented in randomly selected locations on the screen. Targets could be any of seven colors (black, red, yellow, green, blue, purple, white). After the target was displayed, a blank screen appeared for 900 ms, followed by a probe screen, which was identical to the target except that one of the boxes was circled. This box could be the same color as on the target screen, or it could have changed colors. Participants indicated whether the box color had changed or remained the same by pressing one of two keys. There were 6 practice trials and 60 actual trials. Reaction time and accuracy were recorded.

Other materials

***Emotion pictures*.** Participants were asked to view two separate sets of pictures, one neutral and one negative, selected from the IAPS picture set (Lang, Bradley, & Cuthbert, 2005). The neutral set included 12 pictures and the negative set included 13 pictures, and each picture was presented for 15 seconds. Neutral and negative pictures were presented in separate blocks, as described in the procedures section. Negative pictures for this section were selected to be thematically similar to the pictures selected for Study 2. More details about the selection process for negative pictures are available in Appendix B. Neutral pictures were included to 1) help dampen the orienting response by acclimating participants to the picture presentation procedure and 2) give us physiological measures of the orienting response to pictures that I could use as a covariate or within-subjects variable if necessary.

***Emotion rating form*.** This form was created to obtain measures of self-reported emotional reactions. The first question asked participants to rate how positive or negative they felt during the last task, on a scale from 0 to 8, with 0 being very negative, 4 being neutral, and 8 being very positive (valence). Participants were then asked to rate "how strong were the emotions [they] felt during the last task" on a 0 to 8 scale, with 0 being no emotion at all and 8 being strongest ever felt (strength of emotion). Following these two questions, participants were asked to rate how strongly they felt each of 9 emotions on a 0 to 8 scale, with 0 being no emotion and 8 being strongest ever felt. These emotions included amusement/humor, anger, contentment, compassion, disgust, enthusiasm/excitement, fear, sadness, and surprise. These emotions were the ones most likely elicited by the set of IAPS slides.

***Physiological measures*.** Peripheral physiological measures taken continuously throughout the study included measures from various organ systems. All of these measures are frequently included in studies of emotion. Our measures were synced to our computer-presented experiment to allow precise timing. The measures included: blood pressure (systolic and diastolic—used to calculate MAP and TPR), cardiac interbeat interval (IBI; the amount of time between heart beats) which is more sensitive than heart rate, skin conductance level (TSCL—which is the general level of conductivity and is sensitive to stress), skin conductance response count (SCR--number of distinct skin conductance peaks, which is sensitive to orienting responses), finger pulse amplitude and finger pulse transmission time (not used in the current study, ear pulse transmission time (not used in the current study), respiration period and respiration depth. From these measures I could also assess total peripheral resistance (TPR), respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP). Our measures (other than RSA, which is sensitive only to parasympathetic responding) were intended to be used to calculate a composite sympathetic arousal index (SA index) by normalizing scores for each measure and averaging the z scores for each measure for the time point, as has been done in previous research (Shiota & Levenson, 2009).

The recovery tasks. Each recovery task included instructions and two practice trials prior to the negative picture presentation. This was selected so that the experimenter did not have to interact with the participant following the emotion induction because interaction with the experimenter creates a strong physiological reaction that can interfere with measuring physiological indicators of emotional recovery. In addition, each task alternated between a “think” phase and a “write” phase. During the “think” phase, participants were asked to do the task in their head but not to write anything down. This was important because movement can impact physiological recordings. The first “think” phase directly followed the emotion induction and lasted for 60 seconds, a time period that was selected based on Fredrickson and Levenson’s (1998) findings that participants tend to physiologically recover from inductions within 60 seconds. Following the first think phase of each task, participants alternated between “think” and “write” phases that lasted 30 seconds.

FAS fluency task. The FAS task was chosen as the distracting task. The FAS fluency task required participants to name, as quickly as they could, as many words that start with a target letter as possible (Borkowski, Benton, & Spreen, 1967). Typically, this task includes the letters F, A, and S. In our version of the task, participants were consecutively presented on the computer screen with 5 letters for 30 seconds each. During “think” phases, participants thought of words that start with the presented letter, and then in the subsequent “write” phase, participants were asked to write down each of the words that they thought of during the “think” phase. Letters were presented in random order, but each participant viewed the same letters as every other participant.

The FAS task was selected because prior research has suggested that it allows fewer task unrelated thoughts (mindwandering) compared to other tasks, possibly because it has higher need for executive control (Smallwood, Obonsawin, & Reid, 2002). The task, therefore, seemed like a good candidate for an external distraction task.

***SOC task*.** The stream-of-consciousness (SOC) task asked participants to write about whatever they were thinking about. There were two groups: those instructed to think about whatever they like (uninstructed SOC), and those instructed to think about whatever they like *but try to distract themselves from the pictures they have just seen* (instructed SOC). During think periods, participants were told to think about whatever came to mind such as “memories, feelings, images, fantasies, plans, sensations, observations, daydreams, objects that catch your attention or efforts to solve a problem”. During writing periods, they were told to do the same thing, but write down what they were thinking about instead of just thinking it. These instructions were adapted from Kelly and Kahn (1994). During writing sections, participants were asked to write their responses on a notepad provided.

The SOC task was chosen for several reasons. First, it had a similar written response format to the FAS, which allows for similar movement and therefore similar impact on the physiological measurements during write periods (if I wanted to look at that data). Second, this condition provided very little environmentally elicited distraction. Distraction aimed at regulating emotions would have to be provided by the participant. In addition, the SOC task gave us a record of the participants’ thoughts that can be used to gain more details about what they thought about and how they distracted themselves, ruminated, or tried to reappraise. Third, I could have chosen another cognitive task that was less distracting than FAS, but older adults might be more easily distracted with lower levels of difficulty, which would make results difficult to interpret. In addition, I was particularly curious how participants would self-distract when self-distractions were not made readily available in the environment.

During the “think” phases of the task, participants were asked to think about whatever they want, and during the “write” phases, they were asked to write down the thoughts they were having.

Mindwandering probes. After every 30 seconds that elapsed during the task (FAS, SOC etc), a mindwandering probe appeared. Thought probes spaced at approximately 30 seconds have been advocated by Giambra (1995). The FAS and instructed SOC condition participants were asked 1) “Since the last time you were asked, have you had any thoughts about the negative pictures you viewed earlier” and 2) “Since the last time you were asked, have you had any other off-task thoughts?” This gave us an indicator of how distracting our task was and whether it successfully reduced thoughts about the negative pictures. The uninstructed SOC condition participants were only asked the first question, as it did not make sense to ask them if they had off-task thoughts, since they were allowed to think about whatever they wanted. Mindwandering probes allowed us to further assess whether participants were thinking about the negative pictures, in addition to what I can glean from the SOC writings. Participants answered “yes” or “no” to each probe and their responses were recorded by the computer.

Follow-up questionnaire. This questionnaire was aimed at further examining mind wandering by asking participants to rate their mind wandering after-the-fact. This provided us with an opportunity to get an estimate of number of times the participant mind wandered and amount of time spent mind wandering, to compliment information gained from the probes. This questionnaire asked the participant how many times their mind wandered from the task, how much effort they put into the task, how difficult it was to concentrate on the task, how many times they thought about the negative pictures during the task, and how much time (in seconds) they spent thinking about pictures from earlier during the task. The benefit of these types of questionnaires is that mind wandering probes could miss certain types of information. For example, if people mind wander several times during a probe interval, the probes cannot detect this, but retrospective reporting would allow us to capture this information. However, retrospective reporting may be distorted somewhat by people's self-perceptions and memory. In the case that all of the mindwandering measures did not evidence similar patterns, I planned to rely on the mind wandering probes, as they put fewer burdens on memory.

Two additional questions were borrowed from Richards & Gross, 2006. They asked 1) once the pictures were over and you were doing the next task, to what extent did you try to distract yourself from the pictures by thinking about other things and 2) once the pictures were over and you were doing the next task, to what extent did you try not to think about the pictures? Participants answered on an 11 pt scale (0 not at all, 10 a great deal). Answers to these two questions were averaged to create an index.

Procedure

The lab session that included this study occurred after a take-home packet and first lab session. The take-home packet included questionnaires not relevant to this dissertation and the first lab session included the cognitive tasks, such as the working memory and selective attention tasks listed above.

The second lab session took place several days after the first lab session. Participants were welcomed to the lab and the procedures for the day were described to them. They were then asked to wash their hands with soap and lukewarm water. Then, a research assistant hooked up the psychophysiology equipment, calibrated the eyetracker (relevant to study 2) and the experimental session began. During most of the lab session, the experimenter communicated with the participant from a different room, via a speaker system.

Participants were first asked to view the neutral picture set. Specifically, they were asked to pay attention to the pictures. After instructions but prior to picture presentation, participants saw a cross on the computer screen for 120 seconds and were asked to "stare at the cross on the monitor while trying to clear your mind of thoughts, feelings, and memories". This provided a psychophysiological baseline measurement. Immediately following this, participants were briefly reminded to attend to the pictures, and then the pictures began. Each picture was presented for 15 seconds, for a total of 3 minutes of picture presentation. Immediately afterward, participants filled out an emotion rating form.

Next, participants received instructions for either the FAS or SOC task. In all conditions, they were also warned that the task would be interrupted periodically by questions that would appear on the screen. They were told to answer these questions when they appeared and then continued on with the task. Participants were encouraged to ask questions, and then began the practice trials. After 60 seconds of the think portion of the task, the mindwandering probe appeared. After answering the probe, the FAS participants were presented with a screen that asked them to “write X words” (with X being a specific letter). The SOC participants were presented with a statement that said “Continue writing about whatever you are thinking about” (uninstructed) or “Continue writing about whatever you are thinking about, but try to distract yourself from the pictures you saw earlier” (instructed). The computer program continued presenting mindwandering probes at 30 second intervals, with FAS or SOC task continuing in between. There were two practice trials (two “think” phases and two “write” phases).

Following practice of the FAS or SOC task, participants were given instructions for viewing the set of negative pictures. The instructions were similar to the ones given before the neutral pictures, except that participants were told: “Now you will view some new pictures on the computer screen. While you view the pictures, please try not to regulate your emotions. Watch the pictures carefully and try to let your emotions happen naturally without trying to get rid of them”. Immediately after the pictures end, participants rated their emotions. Then a screen briefly reminded them about the FAS or SOC task and they began the task, as described above. At the end of the FAS or SOC task, they completed a final emotion rating questionnaire.

After completion of the emotion rating form, the experimenter entered the room and gave the participant the follow-up questionnaire. Following this, participants were given an opportunity to take a break, and then began the procedures for Study 2.

Analyses

Manipulation Checks

Mindwandering manipulation. There were three variables measuring negative mindwandering: the mindwandering probes, retrospective frequency count, and retrospective estimate of time spent mindwandering. The FAS task was specifically chosen because it was believed that it would limit mindwandering about the negative pictures relative to the SOC task. This assumption was tested using a 2 (condition: SOC uninstructed vs FAS) X 2 (age group) univariate ANOVA with the mindwandering measure as the dependent variable.

The omnibus ANOVA comparing negative mindwandering counts revealed a significant main effect of condition $F(1, 133) = 15.648$, $p < .001$, partial eta squared = .105. See Figure 1. Results were similar for retrospective frequency counts $F(1, 133) = 16.255$, $p < .001$, partial eta squared = .109. These results were further supported by participants' estimates of time spent mindwandering $F(1, 134) = 9.3$, $p < .005$, partial eta

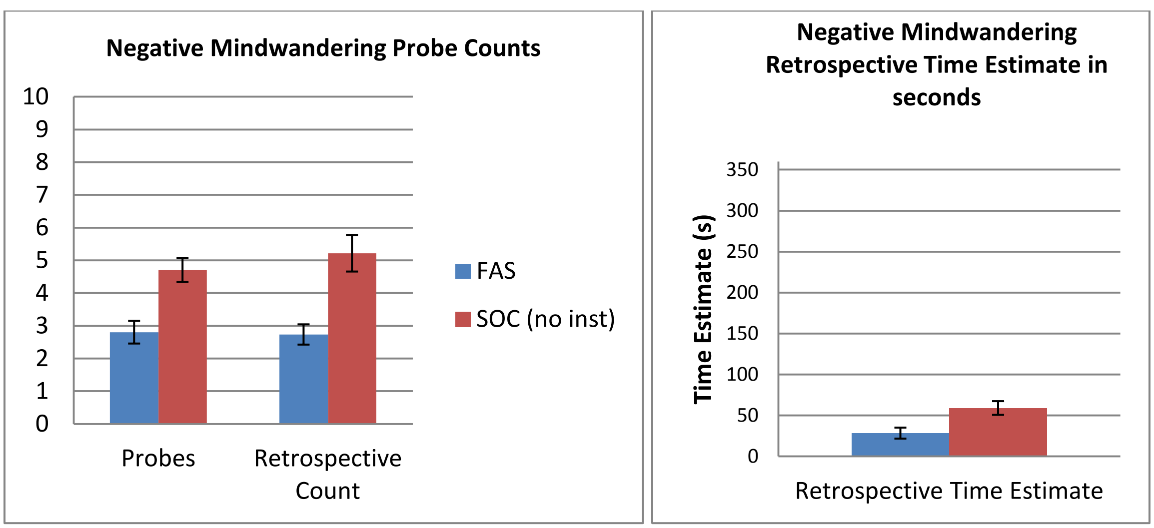

Figure 1. Negative mindwandering variables by condition, comparing FAS with the uninstructed SOC condition.

***Emotion induction*.** Checking emotion induction involved examining both self-report and physiological variables for evidence that presentation of the negative pictures altered these measures.

Self-report. To confirm that the pictures elicited a negative emotional reaction, separate 2 (age group) X 3 (condition) X 2 (trial type: neutral versus negative) repeated measures ANOVAs were conducted using positive self-reported affect (PA), negative self-reported affect (NA), and valence self-reports as dependent variables in separate analyses, with age group and condition as between subjects variables and trial type (neutral versus negative picture presentation) as the within subjects variable.

For analysis conducted with PA, there was a significant main effect of trial type $F(1, 212) = 193.942$, $p < .001$, partial eta square = .478, such that participants reported less PA following the negative induction. No other main effects or interactions were statistically significant. For analysis conducted with NA, there was a significant main effect of trial type $F(1, 212) = 1045.916$, $p < .001$, partial eta squared = .831, such that participants reported greater negative affect during the negative pictures than during the neutral ones. Analyses also revealed a significant main effect of age group $F(1, 212) = 18.396$, $p < .001$, Partial eta squared = .08. There was also a statistically significant trial type X age group interaction effect $F(1, 212) = 13.544$, $p < .001$, Partial eta squared = .06, wherein older adults reported greater increases in NA from baseline to viewing of negative pictures. Follow-up comparisons for each trial type suggest that there is no difference in NA during the neutral trials, but there is a significant difference between young and old during the negative trials. There was no significant three-way interaction. These results suggest that older adults experienced greater induction of NA compared to young adults. Failure to find a similar pattern in PA may be due to the fact that PA for both age groups was very near floor at time 2.

squared = .065. For each metric, participants in the SOC condition mindwandered about negative pictures approximately twice as much as participants in the FAS condition, supporting the assumption that the FAS task would help limit mindwandering. The mindwandering manipulation appeared to work.

Analysis was also conducted on data from a valence question. The analysis also indicated a significant effect of trial type $F(1, 212) = 603.165$, $p < .001$, Partial eta square = .74, and a trial type X age group interaction $F(1, 212) = 9.875$, $p < .005$, partial eta square = .045. Follow-up t-tests reveal that older adults rated themselves as more positive on the general scale before the induction, $t(155.147) = -3.37$, $p < .001$, but equivalent to young adults after the induction, $t(181.795) = 1.042$, $p = .299$. Both groups reported decreases in overall affect following the induction. Coupled with the PA and NA analysis, this analysis suggests that both age groups experienced an effective emotion induction, though older adults reacted more strongly than young adults did. See Figures 6, 7, and 8.

Physiological measures. Initially, I intended to combine most physiology variables into a physiological index of sympathetic activation. However, factor analysis on the variables did not provide good evidence for creating a single variable in this case. Consequently, variables were examined separately. In physiological variables, change from baseline is more psychologically meaningful than absolute value at a particular time point, which is largely effected by other factors. Therefore, change from baseline (time) effects are crucially important. Further, I designed both studies to allow comparison of an epoch of interest to a control trial within participant. In study 1, participants' reactions during the negative picture presentation was compared to reaction to neutral pictures presented earlier. This helps to account for changes in variables over time, like orienting effects that are present simply because people are viewing pictures and that may have nothing to do with emotion-related arousal, which was the variable of interest. In study 1, for most physiology variables, 2 (time: trial versus baseline) X 2 (trial type: neutral versus negative) X 2 (age group) X 2 (sex) X 3 (condition) repeated measures ANOVAs were conducted, with sex and age group as between subjects factors, time and trial type as within subjects factors, and the physiology variable of interest as the dependent variable. For certain variables, this type of analysis was not possible, and alternate analyses were used, as described when relevant. The goals of these analyses were to 1) identify whether there was evidence for physiological arousal associated with emotion induction and 2) determine whether it was possible to track time-to-physiological-recovery from an induction. The interaction of time and trial type was necessary for testing of hypotheses, and certain main effects of trial type are important for demonstrating effective induction, so results will only be discussed in the body of the paper if they include one of these effects. Other interesting effects will be discussed in Appendix C.

PEP. The omnibus ANOVA revealed a significant main effect of trial type $F(1, 166) = 4.130$, $p < .05$, partial eta squared = .024, with participants demonstrating longer PEP during the negative epoch than the neutral epoch. This was qualified by a significant trial type by condition interaction effect $F(2, 166) = 4.387$, $p < .05$, partial eta squared = .05. Follow-up ANOVAs were conducted within each condition to investigate this effect. Within the FAS and instructed SOC conditions, there was no significant difference in PEP between the neutral and negative epochs. In the uninstructed SOC condition, however, there was a significant effect of trial type $F(1, 56) = 6.234$, $p < .05$, partial eta squared .074, with participants demonstrating a longer PEP during the negative epoch relative to the neutral one. See Figure 2.

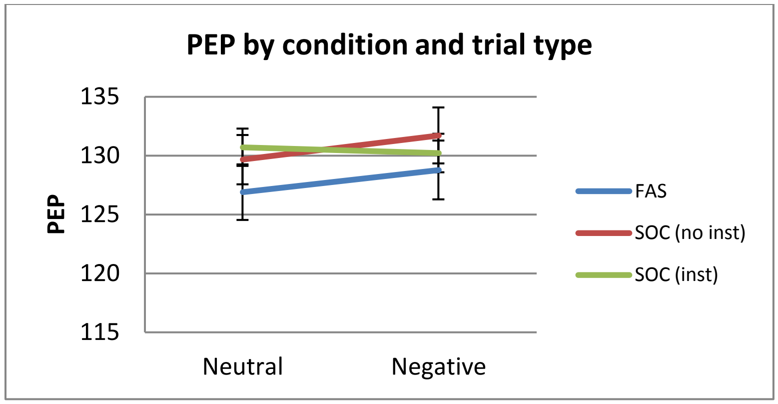

Figure 2. Pre-ejection period by recovery condition and trial type.

At the point they viewed negative pictures, participants in each condition had already received instructions for their recovery task condition. Participants in the FAS condition had practiced coming up with words and participants in the instructed SOC condition had practiced writing down their thoughts while trying to ignore pictures they had just seen. Participants in the uninstructed SOC condition had practiced writing down their thoughts only. It is possible that practicing the FAS task or practicing trying not to think about pictures impacted people's arousal levels. For example, participants in the uninstructed SOC task showed lengthening of PEP during the negative epoch, which came after practicing the tasks, whereas the other conditions did not demonstrate a change in PEP from neutral to negative epoch. This is consistent with decreased arousal in the uninstructed SOC condition, but maintained arousal in the other two conditions. Practicing cognitive tasks such as the FAS and trying to ignore pictures may have kept arousal higher in the other two groups, relative to the uninstructed SOC group.

The PEP results do not involve any significant interactions of time and trial type, and therefore there does not appear to be any evidence for an emotion induction. Because participants' PEP does not appear to leave baseline levels, there is no way to measure time-to-recover to baseline using PEP.

IBI. The omnibus ANOVA revealed a main effect of time $F(1, 188) = 6.068$, $p < .05$, partial eta squared = .031. IBIs increased in length from baseline to trial, consistent with an orienting effect to the pictures. This effect was qualified by a time X trial type interaction $F(1, 188) = 7.653$, $p < .01$, partial eta squared = .039, see Figure 3. Follow-up ANOVAs were conducted separately for the neutral and negative epoch. In the neutral epoch, there is no significant change from baseline to trial in IBI. Within the negative epoch, there was a significant main effect of time $F(1, 199) = 22.725$, $p < .001$, partial eta squared = .102, such that IBI was significantly longer during the trial period relative to the baseline. Increased arousal is typically related to decreased IBI, but orienting effects work in opposition to this effect. Because IBI did not increase, IBI cannot be used to examine time-to-recovery. However, the results do suggest that the equipment was working, and that participants oriented more to the negative than neutral pictures, which is consistent with the negative pictures being more attention grabbing.

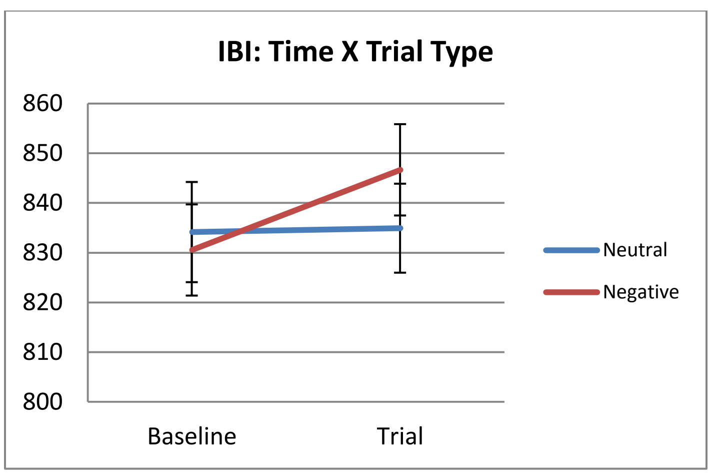

Figure 3. Interaction effect of time and trial type in IBI variable. Neutral n = 200, Negative n = 201.

TPR. No time X trial type effects were significant. The TPR results do not demonstrate an induction effect and consequently cannot be used to investigate recovery.

MAP. The omnibus ANOVA revealed a significant main effect of age group $F(1, 161) = 8.009$, partial eta squared = .047, such that older adults had higher MAP. No other effects were significant.

EDA. For EDA, I used measures of TSCL, which is sensitive to stress, and SCR count, which is sensitive to orienting responses. There was a significant trial type X time interaction in the TSCL data $F(1, 185) = 26.682$, $p < .001$, partial eta squared = .126, see Figure 4. Follow-up repeated measures ANOVAs within each trial type demonstrate that there are significant decreases in TSCL from baseline to trial in the neutral condition, $F(1, 196) = 76.108$, $p < .001$, partial eta squared = .280, but there was no significant change from baseline to trial in the negative condition. The interaction effect is consistent with successful emotion induction. Unfortunately, failure to find a significant change from baseline to trial in the negative picture condition means that I cannot use TSCL to look at time-to-recover from the negative pictures.

A 2 (trial type: neutral versus negative) X 2 (age group) X 2 (sex) X 3 (condition) repeated measures ANOVA was also conducted using number of SCRs as the dependent variable. The omnibus ANOVA revealed a marginally significant main effect of trial type $F(1, 185) = 3.630$, $p = .058$, partial eta squared = .019, such that participants displayed higher SCRs when viewing negative pictures, compared to neutral ones, as would be expected in an orienting response (Figure 5). No other effects were significant.

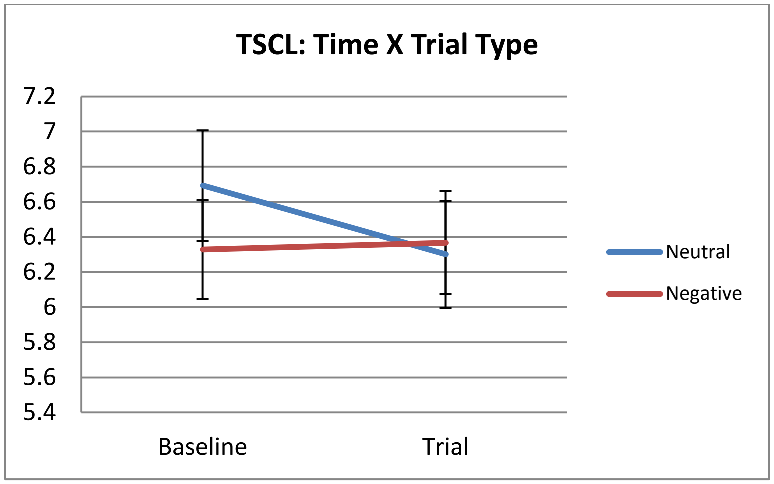

Figure 4. Time X trial type interaction in TSCL. N = 197.

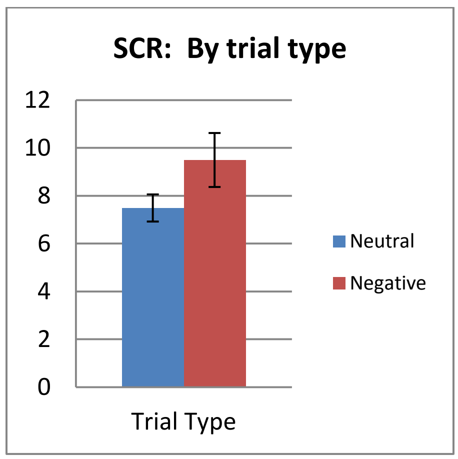

Figure 5. Skin conductance response count by trial type.

Correlations between self-report and physiological variables. Although condition effects did not always seem consistent with emotion induction, correlations between physiological variables and self-reported emotion variables across participants did support the conclusion that physiological variables were sensitive to emotion in expected ways. Correlations were calculated by regressing the physiological measure during the negative trial on the same physiological measure during its baseline period and obtaining residuals for each participant. The residuals were then correlated with self-ratings. IBI correlated significantly with self-reports, such that greater decrease in IBI was associated with higher ratings of emotional strength (-.20, higher ratings of negative affect (-.16), as would be expected if IBI is associated with emotional arousal. TSCL also correlated significantly with self-reports, with lower TSCL relating to lower strength of emotion (.22), higher positive affect (-.16), and higher valence ratings (-.26). Higher SCRs were related to higher strength of emotion ratings (.19) and lower valence ratings (.15), consistent with being sensitive to general arousal and general emotion ratings. MAP was also significantly related to self-reports, with lower MAP predicting lower negative affect (.25). Other physiology variables did not correlate significantly with the self-report variables.

Conclusions from physiology variables. Results from the physiological variables generally do not provide consistent evidence of physiological arousal associated with the presentation of the negative pictures. Outcomes of many of the physiological variables are multiply determined, and failure to indicate emotional arousal does not indicate failure to elicit an emotional response. For example, IBI is made longer by orienting effects (and paying attention), but it is made shorter by emotional arousal. However, EDA results (using TSCL) do confirm greater arousal in response to the negative pictures. Further, decreased IBI and increased SCRs are classic components of an orienting response, which demonstrates that equipment was functioning and participants were paying attention to the pictures presented. Also, orienting responses were greater in response to the negative pictures than the neutral ones, as would be expected. Further, correlations between physiological measures and self-reported emotion suggest the physiological measures were sensitive to emotion, even if the effect did not show up in other analysis. Because of the lack of change in physiological arousal from baseline, time-to-recovery from emotion induction cannot be measured using physiological variables. Analyses of recovery will have to rely on self-report variables instead.

An interesting and unexpected finding emerged, however, in the PEP results. It appears that prepping for different conditions differentially impacted participants' arousal. This has implications for study design that will be discussed in the discussion.

Summary of Manipulation Checks

Manipulation checks suggest that 1) the FAS task limited negative mindwandering, as intended, 2) the emotion induction worked both in terms of emotional outcomes and physiological ones, though it appeared to induce stronger emotion in older adults, and 3) the physiological measures cannot be used to investigate time-to-recovery.

Hypotheses Testing

Study 1 was exploratory in nature, and there were competing hypotheses about the nature of age differences in regulation in each condition. I hypothesized that older adults could show maintained, improved, or worsened distraction and emotional outcomes in the three experimental conditions, relative to young adults (see hypotheses 1 through 3). In general, though, improvement in use of distraction was defined as quicker or more complete reduction in negative emotions (as evidenced by self-reports and physiological indicators, though physiological indicators cannot be used given above analysis) and a reduction in negative mindwandering/rumination. Worsening in ability to use distraction in a particular condition should result in less decrease or slower decrease in negative affect and greater mindwandering/rumination . Memory was also expected to vary with the use of distraction, such that people would have worse memory for stimuli in conditions where they distracted themselves effectively (see hypotheses 1 through 3).

Study 1 also examined the contributions of cognitive resources to successful down-regulation of emotion and the mediating role of negative mindwandering (see hypothesis 4), and it investigated whether intention-to-regulate predicted successful regulation (see hypothesis 5).

Emotional Outcomes

***Self-reported emotion*.** Separate 2 (time: induction vs recovery) X 2 (age group) X 3 (condition) repeated measures ANOVAS with time as the within subjects factor, and age group and condition as between subjects factors, were conducted for NA, PA and valence variables.

Negative affect. The omnibus ANOVA demonstrated a significant main effect of age $F(1, 213) = 25.493$, $p <.001$, partial eta squared = .107, such that older adults reported significantly greater negative affect compared to young adults, overall, which reflects the higher reaction to the induction. There were also main effects of time $F(1, 213) = 273.484$, $p < .001$, partial eta squared = .562, and condition $F(1, 213) = 6.617$, $p < .005$, partial eta squared = .058, both of which were qualified by a significant time by condition effect $F(2, 213) = 6.301$, $p < .005$, partial eta squared = .056. There was no significant 3-way interaction, suggesting that older and younger adults did not differ in patterns of recovery (see Figure 6), in contrast to expectations of hypotheses 1 through 3.

Follow-up 2 (condition) X 2 (time) repeated measures ANOVAs compared each condition to each other condition. There was a significant 2 (condition) X 2 (time) interaction effect when comparing NA in the FAS condition and uninstructed SOC condition $F(1, 144) = 14.044$, $p <.001$, partial eta squared = .089. There was also a significant interaction effect when comparing NA in the FAS condition and the instructed

SOC condition F(1, 145) = 4.86, $p < .05$, partial eta squared = .032. But there was no significant interaction when comparing the two SOC conditions to each other. Analyses comparing induction NA to recovery NA for each condition confirmed that for all three

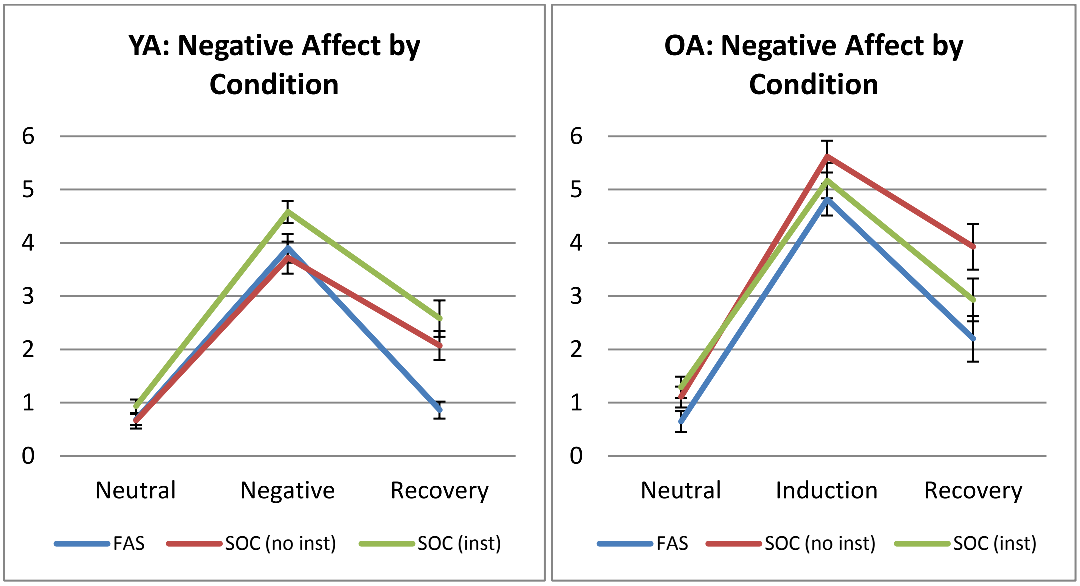

Figure 6. Negative affect self-report ratings by age group and condition. YAs: FAS n = 42, SOC (no inst)n = 42, SOC (inst) n = 39. OAs: FAS n = 32, SOC (no inst) n = 30, SOC (inst) n = 34.

conditions, people decreased significantly in NA during the recovery period [FAS: F (1, 73) = 142.929, $p < .001$, partial eta squared = .662; instructed SOC: F (1, 72) = 79.423, $p < .002$, partial eta squared = .525; uninstructed SOC: F(1, 71) = 65.592, $p < .001$, partial eta squared = .48]. An ANOVA comparing conditions at each time point revealed that while there was no main effect of condition during the induction, there was a significant main effect of condition during the recovery period F(2, 216) = 9.782, $p < .001$. Follow-up post-hoc Tukey’s HSD tests confirm that participants in the FAS condition demonstrated significantly lower NA than those in either SOC condition. These results suggest that participants in the FAS condition down-regulated their NA more than those in either SOC condition, and participants in the instructed SOC condition did not regulate

NA any more than those who were given no instructions. However, participants in all conditions did decrease in NA over time.

NA during recovery in each condition was also compared to NA during the neutral picture trial, to determine whether NA may have returned to pre-negative induction baselines. NA was significantly elevated during recovery relative to neutral picture presentation for all conditions[FAS: $F(1, 73) = 12.827$, $p < .001$, partial eta squared = .149; instructed SOC: $F(1, 72) = 40.337$, $p < .001$, partial eta squared = .359; uninstructed SOC: $F(1, 71) = 61.132$, $p < .001$, partial eta squared = .463], suggesting that though participants did successfully decrease NA from induction to recovery period, they did not completely eliminate all NA.

Positive affect. The omnibus ANOVA revealed a significant main effect of time $F(1, 213) = 59.322$, $p < .001$, partial eta squared = .219, such that PA was higher in the recovery condition compared to the induction period. There were no other significant main effects or interaction effects (see Figure 7). The results suggest that participants improved in PA during the recovery period, but that this did not depend on age or condition, contrary to expectations. Comparing the recovery period PA to neutral picture PA revealed a main effect of trial type $F(1, 216) = 22.313$, $p < .001$, partial eta squared = .094, suggesting that participants did not completely recover to pre-induction levels of PA.

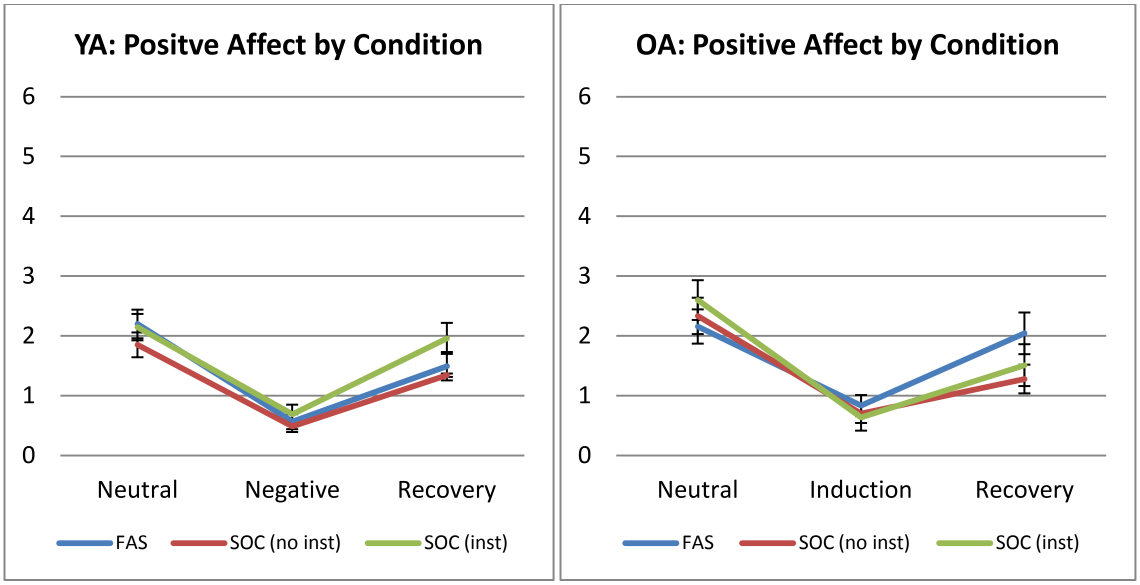

Figure 7. Positive affect by condition for each age group. YAs: FAS n = 42, SOC (no inst)n = 42, SOC (inst) n = 39. OAs: FAS n = 32, SOC (no inst) n = 30, SOC (inst) n = 34.

Valence. The omnibus ANOVA revealed a significant main effect of time F(1, 213) = 198.045, p < .001, partial eta squared = .482, such that valence was higher during the recovery period than the induction period, once again indicating successful emotional recovery that did not depend on age or condition. No other main effects or interaction effects were significant (see Figure 8). A comparison of the recovery period valence to the neutral picture valence revealed a main effect of trial type F(1, 216) = 85.137, p < .001, partial eta squared = .283, with valence lower for the recovery period. This also suggests that participants did not completely recover to pre-induction levels of valence. As with results for the other emotion variables, the lack of age differences in recovery were inconsistent with hypotheses 1 through 3, as older adults neither improved or struggled more with emotion regulation in any condition.

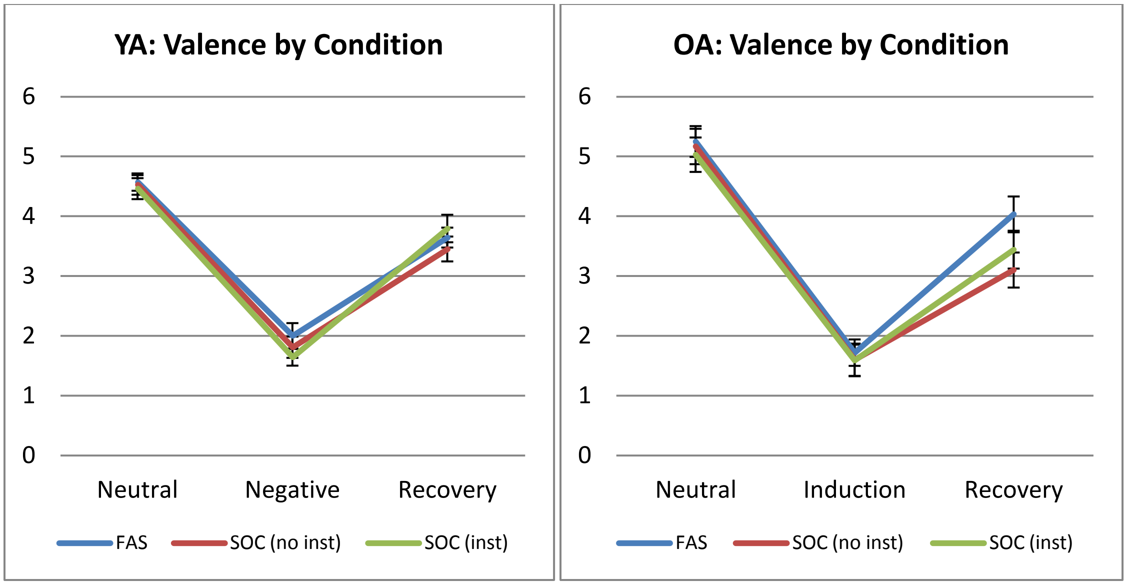

Figure 8. Valence by condition separately for young and older adults. YAs: FAS n = 42, SOC (no inst)n = 42, SOC (inst) n = 39. OAs: FAS n = 32, SOC (no inst) n = 30, SOC (inst) n = 34.

Physiological measures. Unfortunately analysis during recovery could not be conducted because of the lack of change from baseline to trial in the physiological variables. Therefore, time estimates to recovery cannot be calculated in this study.

Negative Mindwandering. When planning Study 1, three mindwandering variables (described earlier) were included in study design. As suspected, the three mindwandering variables did not provide identical results, so I will primarily depend on the mindwandering probe results, as originally intended. Full analyses will be reported for the mindwandering probe variable and summaries of the retrospective frequency counts and retrospective estimates of time spent mindwandering will be discussed briefly in the body of the dissertation, but full analyses for these variables are available in Appendix D.

Separate 2 (age group) X 3 (condition) univariate ANOVAS were conducted for each of the three mindwandering measures. Analysis using negative mindwandering probe responses as the dependent variable reveal a significant main effect of age, F (1,

198) = 6.072, $p < .05$, partial eta squared = .029, such that older adults mindwandered more than young adults. A main effect of recovery condition also emerged, $F(2, 198) = 9.236$, $p < .001$, partial eta squared = .085. Follow-up Tukey's pairwise comparisons demonstrated a significant difference when comparing the uninstructed SOC condition to either other condition, such that those in the uninstructed SOC condition reported greater negative mindwandering[1]. There was no significant interaction effect. I also conducted follow-up pairwise 2 (condition) X 2 (age group) ANOVAS comparing each set of conditions, due to a priori hypotheses. No interaction effects were significant. In comparing age groups within each condition, there were significant differences in each SOC condition, as suggested by the omnibus ANOVA, but there was not a difference in negative mindwandering in the FAS condition. See Figure 9 for depiction of negative mindwandering probe data. Analyses were also conducted to compare off-task mindwandering in the FAS condition between the two age groups and marginal effect was found $F(1, 69)=2.904$, $p=.093$, with older adults reporting less off-task mindwandering, consistent with Smallwood's theories.

The results disconfirm the hypothesis 3 expectation that young adults would show greater decreases in negative mindwandering when asked to distract themselves. Instead, it appears that both groups thought about the negative pictures significantly less when asked to do so and to about the same degree. Interestingly, results also suggest that older adults, not young adults, thought about the negative pictures more in both of the SOC conditions, contrary to hypothesis 2 but in line with one possibility posited in hypothesis 3.

[1] I also conducted pairwise 2 (condition) X 2 (age group) ANOVAs comparing each set of conditions, due to a priori hypotheses. These did not yield significant interaction effects either (as suggested by the omnibus ANOVA), and so they were left out of the paper for conciseness and clarity.

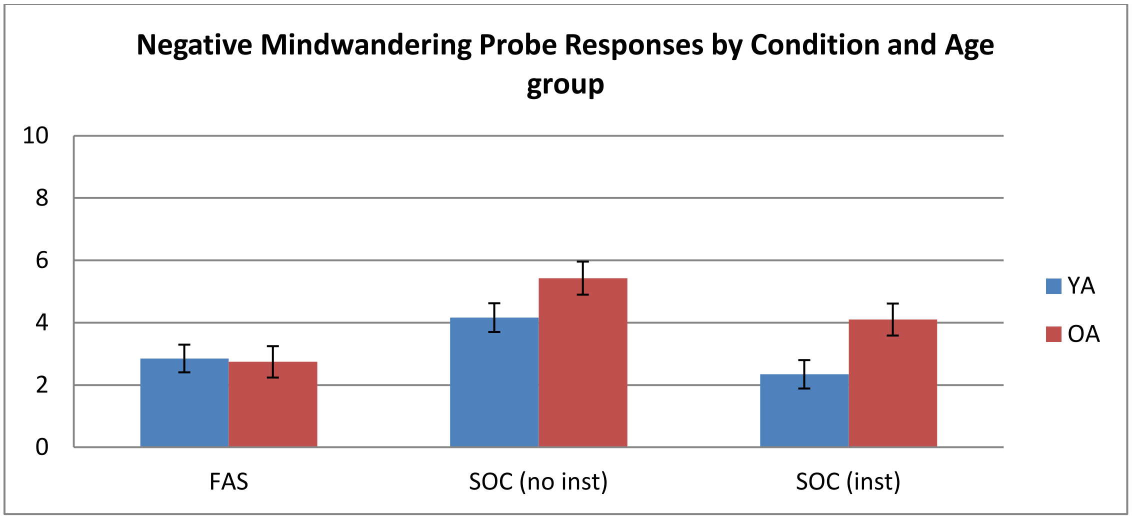

Figure 9. Responses to the negative mindwandering probe for each condition and age group.

However, because emotion analyses suggested that older adults experienced greater response to the emotion induction, which could influence tendency to ruminate, I also conducted the above analysis using the emotion variables at induction as covariates. This version of analysis eliminated the main effect of age $F(1, 196) = 2.061$, $p = .153$, partial eta squared = .010. There was a marginal age group X condition effect $F(2, 196) = 2.759$, $p = .066$, partial eta squared. Pairwise 2 (age group) X 2 (condition) ANOVAs with the emotion covariates revealed that mindwandering estimates were significantly higher in the FAS condition than the uninstructed SOC condition $F(1, 130) = 13.942$, partial eta squared = .097. They were also significantly higher in the uninstructed SOC condition than in the instructed SOC condition $F(1, 127) = 13.695$, $p < .001$, partial eta squared = .097. There was no difference in negative mindwandering in the FAS and instructed SOC conditions. There was, however, an age group X condition interaction effect when comparing the FAS and instructed SOC conditions $F(1, 132) = 4.78$, $p < .05$, partial eta squared = .035. Follow-up ANOVAs comparing age group within each condition revealed that there were no age differences in negative mindwandering in the FAS or uninstructed SOC conditions, but there was a significant difference in the instructed SOC condition, such that older adults in this condition mindwandered more than young adults $F(1, 63) = 4.905$, $p < .05$, partial eta squared = .072.

Taking the induction difference into account did not change the majority of results. The FAS condition still resulted in lower mindwandering estimates than the uninstructed SOC condition, supporting the hypothesis that a distracting task would be beneficial. Further, the instructed SOC condition still resulted in decreased negative mindwandering compared to the uninstructed SOC condition and the magnitude of this decrease did not vary based on age group. Also similar to the original analysis: there were no age differences in negative mindwandering in the FAS condition, which was consistent with some theories of mindwandering but not others (and hence, consistent with one expectation from hypothesis 1 but not the other). Another difference was that age differences in the uninstructed SOC conditions were eliminated, suggesting that older adults did not spontaneously think less about the negative pictures, but also did not think more about them (still inconsistent with hypothesis 2). Age differences in mindwandering in the instructed SOC condition remained (still inconsistent with hypothesis 3).

The same analyses (without the covariate) were also conducted using the retrospective MW count and retrospective time estimates given by participants following the recovery period. One reason for using the probes was to limit the degree to which people might be relying on general self-impressions and memory when making assessments of the degree to which they had repetitive thoughts about the negative pictures. Retrospective reports might be more biased by these factors, leading to apparent differences in negative mindwandering. The results from our retrospective reports do suggest a different pattern than the probe results (see Appendix D for analyses and charts). But the pattern difference appears to be driven by young adults estimating significantly higher levels of negative mindwandering retrospectively, as compared to online, whereas older adults make similar estimates regardless of how their negative mindwandering is measured. This increase in estimate leads to young adults appearing to experience equivalent mindwandering to older adults in the SOC conditions, but more negative mindwandering in the FAS condition. Possible implications for the reason hypothesis 2 was not confirmed will be discussed in the discussion.

Relationship of negative mindwandering to emotional outcomes. Degree of negative mindwandering (as measured by probes) correlated with both the emotion self-reports following induction and the degree of recovery in emotion following the recovery period (calculated by subtracting self-report rating after induction from the self-report rating after the recovery period; See Table 1). People who experienced a greater induction (higher negative affect, lower valence) reported greater mindwandering following the induction. When separated by age group, there was a significant relationship of mindwandering probe report to level of negative affect after induction (to a similar extent in both groups). It appears that the greater the induction, the more people continued to ruminate about the pictures during the recovery period.

Further, mindwandering during the recovery period also correlated significantly with degree of recovery during the same period. People who mindwandered more reported greater improvement in negative affect, positive affect and valence. When split on age group, a similar relationship emerged, although the relationship between mindwandering and valence ratings was no longer significant for young adults. Although mindwandering and degree of recovery did not always seem to correspond when comparing experimental conditions (such as comparing the two SOC conditions), degree of mindwandering did predict degree of recovery. Comparison of the magnitude of the correlations between the two age groups (using Fisher’s r-to-z transformation) did not suggest significantly different patterns between the two age groups. Although these results do not directly address any of the hypotheses, they are important in establishing the fact that mindwandering is related to degree of negative emotion and give us more information about the nature of distraction.

Table 1. Correlations of Self-reported Emotion to Negative Mindwandering Probe Count						
	YA		OA		All	
Induction NA	0.27	**	0.28	**	0.31	**
Induction PA	-0.07		0.21		0.08	
Induction Valence	-0.37	**	0.02		-0.15	*
Recovery NA	0.20	*	0.31	**	0.27	**
Recovery PA	-0.20	*	-0.24	*	-0.22	**
Recovery Valence	-0.13		-0.24	*	-0.14	*

*p < .05, **p < .01

Memory. For the recognition memory variables, there was data for the negative pictures but not the neutral pictures. Therefore, differences in memory for the negative pictures was assessed using separate 2 (age group) X 3 (condition) univariate ANOVAs, with each recognition memory variable (central and peripheral detail) as a dependent variable (see study 2 for description of memory variables). For the recall variables, there was data for both the neutral and negative pictures, so 2 (age group) X 3 (condition) X 2 (trial type) repeated measures ANOVAs were conducted, using each recall variable (gist, detail, and false detail) as the dependent variable. The length of delay between the experiment and test was used as a covariate in analyses.

Recognition memory. No significant main effects or interaction effects emerged for recognition memory for the central detail variable. A significant main effect of age was found in the recognition peripheral variable $F(1, 183) = 6.215$, $p < .05$, partial eta squared = .033, such that older adults remembered fewer peripheral details of the pictures. No other significant effects were found. It does not appear that manipulating rumination about the negative pictures during the brief recovery period had any impact on memory for the pictures a day later.

Free-recall memory. In the detail variable, there was a significant main effect of trial type $F(1, 163) = 5.604$, $p < .05$, partial eta squared = .033, such that participants remembered more details about the negative pictures than the neutral ones. There was also a main effect of age group $F(1, 163) = 5.875$, $p < .05$, partial eta squared = .035, such that older adults described more details per picture than young adults did. No other main effects or interaction effects emerged.

In analysis using the false detail variable, there was a trial type X age group interaction $F(1, 164) = 6.924$, $p < .01$, partial eta squared = .041 such that there were no significant differences in false details recalled in the neutral condition, but older adults recalled significantly more false details when describing the negative pictures $F(1, 168) = 8.389$, $p < .005$, partial eta squared = .048. There were no other significant effects.

In analysis using the gist variable, there was a significant main effect of age group $F(1, 165) = 5.154$, $p < .05$, partial eta squared = .030 and a significant main effect of trial type $F(1, 165) = 236.946$, $p < .001$, partial eta squared = .589, but these main effects were qualified by a trial type by age group interaction effect $F(1, 165) = 7.897$, $p < .01$, partial eta squared = .046. This interaction was followed-up by comparing the two age groups for each trial type. There were no significant age differences in gist recall for the neutral trial, but there was a significant main effect of age group for the negative trials $F(1, 169) = 7.638$, $p < .01$, partial eta squared = .043, such that older adults recalled fewer pictures than did young adults. No other effects emerged.

In summary, older adults recalled fewer negative pictures than young adults and were more likely to recall false details associated with the pictures they did describe. These findings are consistent with a reduced negativity bias in older adults' memory performance, which are found frequently in aging research.

There were no effects in any variable that included differences between conditions, contrary to expectations of hypotheses 1 through 3. Although our hypotheses suggested that memory recall should differ among people who successfully distracted themselves (such as those in the FAS or instructed SOC condition), I found no support for this hypothesis.

Correlations to other measures. I also examined some correlations to see whether there may be evidence for effects using an individual differences approach that were not evident when comparing conditions. I also wanted to further explore possible reasons for the reduced negativity effect in older adults.

To investigate whether degree of thought about negative pictures predicted memory recall (to see if successful distraction limited recall as expected), I examined the correlations between the negative mindwandering probe count and the various memory measures. Negative mindwandering did significantly predict gist recall ($r = .17$, $p < .05$), central detail recognition ($r = .19$, $p < .01$) and marginally predicted detail recall ($r = .14$, $p = .077$), such that people with higher negative mindwandering better remembered the negative pictures a day later. Interestingly, when correlations were calculated separately by age group, correlations were only significant for the young adult group (gist: $r = .28$, $p < .01$, detail: $r = .25$, $p < .05$, central detail: $r = .33$, $p < .001$) but not older adults (gist: .16, $p = .19$, detail: $r = .07$, $p = .55$, central detail: $r = .12$, $p = .292$). It appears that ruminating during this three minute window assisted young adults with later memory but had less impact on older adults' memory.

To investigate whether physiological arousal predicted later memory, I examined correlations between each physiological indicator (using residuals from regressing the trial on the baseline) to each memory variable. Gist memory was marginally correlated to IBI in each age group (YA: $r = -.18$, $p = .096$; OA: $r = .21$, $p = .074$), but the difference in correlations was significantly different, using Fisher's r-to-z ($p<.05$). In the young adult group, higher gist memory was associated with greater reductions in IBI, meaning that greater emotion-related physiological arousal lead to greater memory. In the older adults, however, higher gist memory was related to greater increases in IBI, which could reflect either greater emotional arousal or lower orienting responses. Therefore, it unexpectedly appears that arousal impacted later gist memory in different ways in older and younger adults.

SOC writings. The writings were coded by rating each participant's use of five strategies. Three were planned a priori (distraction, rumination, reappraisal) and two were added as I examined the data (analytical, self-direction). Distraction was defined as writing about things not related to the pictures. Rumination was defined as mentioning the pictures in a negative or repetitive way. Reappraisal was defined as mentioning the pictures in a way that changed their meaning and made them less emotional. Analytical was defined as talking about the pictures, but as if asking questions about the content of the pictures or trying to understand the pictures (such as, "where was that ship located?"). Self-direction involved writing about telling one-self to calm down or focus on something other than the pictures. The inter-rater reliability was calculated for each strategy type using intraclass correlation coefficients estimating consistency. The Cronbach's alphas were .867 for distraction, .794 for rumination, .740 for reappraisal,

.843 for analytical, and .848 for self-direction. Details about the coding scheme can be found in Appendix E.

Comparing Conditions. Each of the variables was subjected to a 2 (age group) X 2 (condition) ANOVA[2]. There were no significant interaction effects for any of the variables. However, there was a main effect of age in all variables except the reappraisal variable (Figure 10 depicts age differences in variables). Older adults evidenced less use of distraction $F(1, 131) = 9.233$, $p < .005$, partial eta squared = .066, more use of rumination $F(1, 131) = 7.383$, $p < .01$, partial eta squared = .053, more use of analysis $F(1, 131) = 5.490$, $p < .05$, partial eta squared = .04, and more use of self-direction $F(1, 131) = 12.420$, $p < .001$, partial eta squared = .087. Generally, these results are consistent with the idea that older adults, in general, thought more about the negative pictures during the recovery period. They were less likely to distract themselves, but more likely to ruminate and to spend time trying to analyze the contents of the pictures. Whereas analyzing picture content could be helpful in limiting emotions, rates of analysis were very low. Older adults were also more likely to explicitly mention trying to calm themselves down and think about something else, whereas young adults appeared more likely to actually successfully think about something else. These results are not consistent with older adults being more likely or more able to use self-distraction in a recovery context (contrary to expectations in hypothesis 2, but also as alternative outcomes in hypotheses 1 and 3). Also, the lack of an age difference in use of reappraisal is not consistent with prior suggestions that older adults may be more likely to reappraise.

[2] Analysis including affect during induction as a covariate was also conducted. It decreased but did not eliminate age effects.

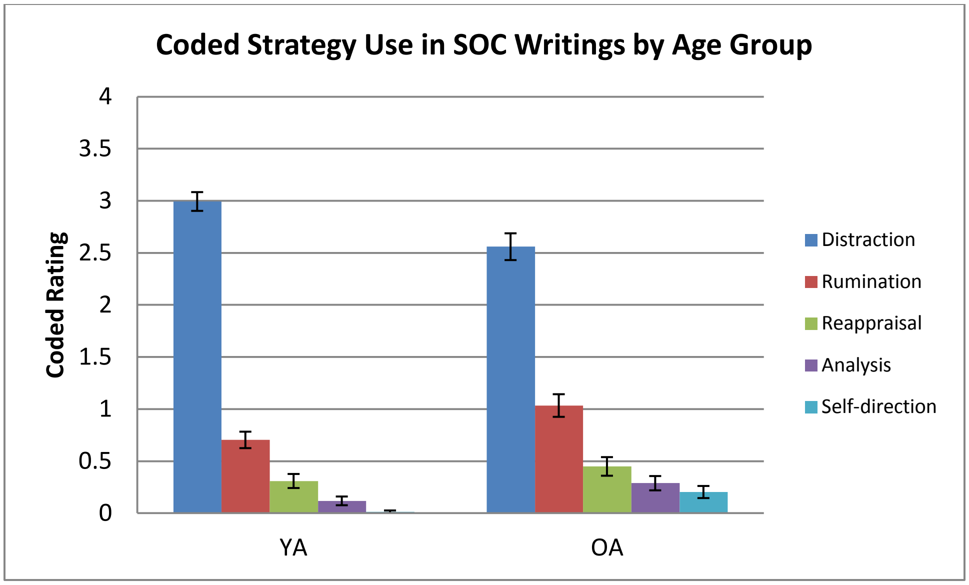

Figure 10. Data from strategies present in the SOC writings, which were coded by coders. YA n = 76, OA n = 59

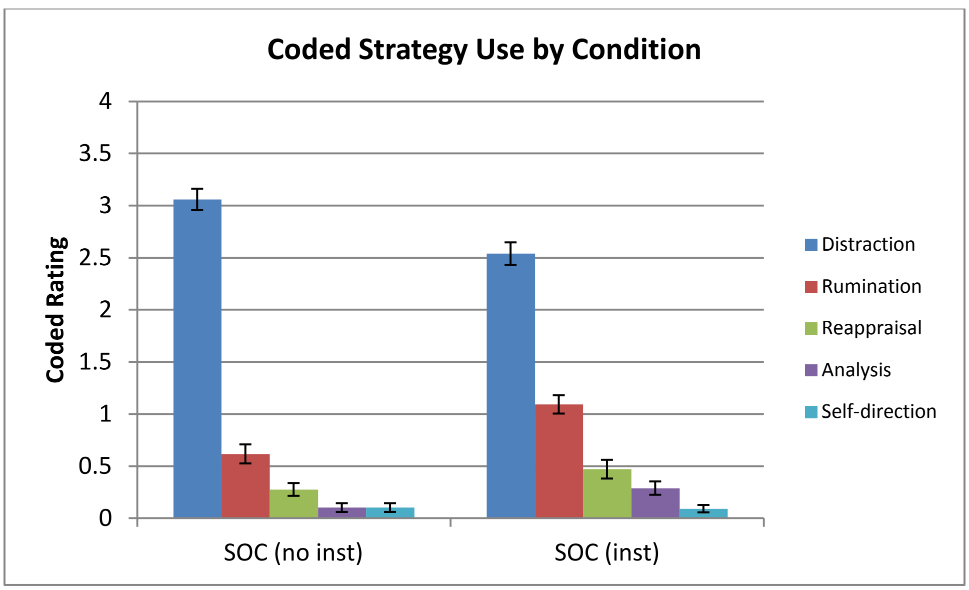

Figure 11. Comparing SOC conditions on strategies present in SOC writings as coded by coders. SOC (no inst) N = 69, SOC (inst) N = 66

Main effects of recovery condition also emerged in most variables. Participants in the instructed SOC condition were more likely to evidence distraction $F(1, 131) = 12.418$, $p < .001$, partial eta squared = .087, less likely to evidence rumination $F(1, 131) =$

14.240, $p < .001$, partial eta squared = .098, less likely to evidence reappraisal $F(1, 131) = 3.840$, $p = .052$, partial eta squared = .028, and less likely to evidence analysis $F(1, 131) = 7.009$, $p < .01$, partial eta squared = .051. There were no differences between conditions of self-direction. These results are consistent with the expectations that participants in the instructed SOC condition would think less about the negative pictures overall, as they were instructed to do.

Role of cognitive control. The cognitive tasks used in the study each went through a data cleaning and inspection process. Some variables also went through transformations to address skewness. Descriptions of these processes are available in Appendix A.

Cognitive latent variable. For the cognitive resource variable, there were many candidate components to be included in the latent variable, such as accuracy and reaction time for most of the cognitive measures. For some measures, accuracy or RT made more theoretical sense (as described in the Appendix A). Correlations between measures were also examined to see whether there appeared to be relationships between variables. Inspection of correlation patterns seemed to suggest two possible cognitive factors: a working memory factor including the visual array and N-back accuracy composite scores with the total RSPAN score and a speed factor including pattern and letter comparison.

Based on this post hoc exploration of the data, I conducted a confirmatory factory analysis in MPLUS (Muthén & Muthén, 1998-2007) using maximum likelihood estimation. The factors were identified by fixing one loading for each factor to 1, and estimating remaining factor loadings, variances, and covariances. The model included two latent factors: a working memory factor based on RSPAN, visual arrays accuracy, and N-back accuracy and a speed factor based on the pattern and letter comparison factors. The model allowed these two latent factors to correlate. The fit indices suggest a good fit: Chi Square = 4.565, df = 4, p = .33), RMSEA = .032 and CFI = .999. As would be expected based on our prior examination of the correlations between variables, each measure loaded significantly on its latent variable, and the two latent variables were correlated (.56).

Emotion latent variable. Degree of recovery in NA, PA, and valence were each calculated by subtracting the self-report at induction from the self-report during the recovery period for each measure[3]. Physiological indicators were not included, since they did not evidence arousal with the induction[4]. Exploratory factor analysis (principal axis factoring) conducted in SPSS suggested that the three self-report measures could be appropriately included in one factor (based on both eigenvalue criteria and examination of the scree plot). CFA was conducted in MPLUS, using a maximum likelihood estimator, and the loading of the valence variable was fixed at 1. All three emotion variables loaded significantly on the same latent factor (standardized loadings on emotion factor: Valence = .75, NA = -.53, PA = .63). Fit indices were not available, however, because the model was just-identified.

Investigating impact of cognitive control on outcomes. First, I examined correlations between the cognitive measure scores, emotion scores, and the negative mindwandering probe variable. Unfortunately, there were no correlations between the cognitive measures and the other variables. This was true even when correlations were calculated separately for each cell of the experiment (split on age group and condition). However, I continued to do some follow-up modeling in case relationships emerged

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[4] EFA also did not indicate that the physiological variables seemed to make a coherent factor.

when looking at latent variable relationships that did not emerge when looking at the component variables.

Models were conducted separately on the data from the FAS participants and the instructed SOC participants due to the expectation that cognitive resources could have different effects on outcomes in these two conditions[5]. The models that were conducted used a maximum likelihood estimator. The measurement models for the latent variables were the same as described above. In one set of models, paths were estimated from the WM and speed latent variables to the emotion latent variable. In the second set of models, paths were estimated from the WM and speed latent variables to the negative mindwandering variable. Although model fit was good for all model sets, and measurement models continued to work in each model with all variables loading significantly on the appropriate latent variable, the paths from the cognitive variables to the emotion variables (ranging from -.11 to .01 for paths from WM to emotion and -.07 to .16 for paths from the speed variable to the emotion variable; p values ranged from .13 to .85) and mindwandering variables (ranging from -.07 to -.02 for paths from WM to the mindwandering variable and -.01 to .1 for the speed variable to the mindwandering variable; p-values ranged from .6 to .95) were nonsignificant in all models. This confirms that these cognitive variables did not predict either emotional recovery or degree of mindwandering in any condition. This finding is consistent with one possible outcome outlined in hypothesis 4: that distraction is not resource demanding. However, it is also possible that distraction does rely on resources and that the current study did not find this relationship for other reasons, which will be discussed in the discussion section.

[5] Another set of models looked specifically within each age group within each condition, with similar outcomes.

Distraction Questionnaire. The two items making up the distraction index were highly correlated (.75), so I averaged ratings for the two items together to form an index, as done by Richards and Gross (2006). A 2 (age group) X 3 (condition) univariate ANOVA was conducted, with age and condition as between subjects variables and the distraction questionnaire index score as the dependent variable (see Figure 12). No significant age or interaction effect emerged. However, there was a significant main effect of recovery condition $F(2, 202) = 164.189$, $p < .001$, partial eta square = .169. Follow-up pairwise comparisons (Tukey's HSD) indicate that participants in the instructed SOC condition reported significantly higher intentional distraction scores, relative to those in the FAS and uninstructed SOC conditions ($p < .001$). Whereas participants in the FAS and uninstructed SOC conditions rated their self-distraction as about a 2.5 on the scale, instructed SOC participants rated their attempts at self-distraction at about a 5.

As expected in hypothesis 5, both age groups report intentionally trying to distract when they were asked to do so. Intentional use of distraction in the other groups, however, was significantly lower, and not much above floor. Intentional use of distraction also did not vary among the two age groups. This is in contrast with the hypothesis 5 expectations that people may spontaneously use self-distraction without intending to do so, especially perhaps older adults.

I also examined correlations between the distraction index score and more objective measures of distraction (negative mindwandering and emotional outcomes). There were no significant correlations between people's ratings of their attempts to distract and their actual performance, either when all participants were included together nor when correlations were examined within each condition.

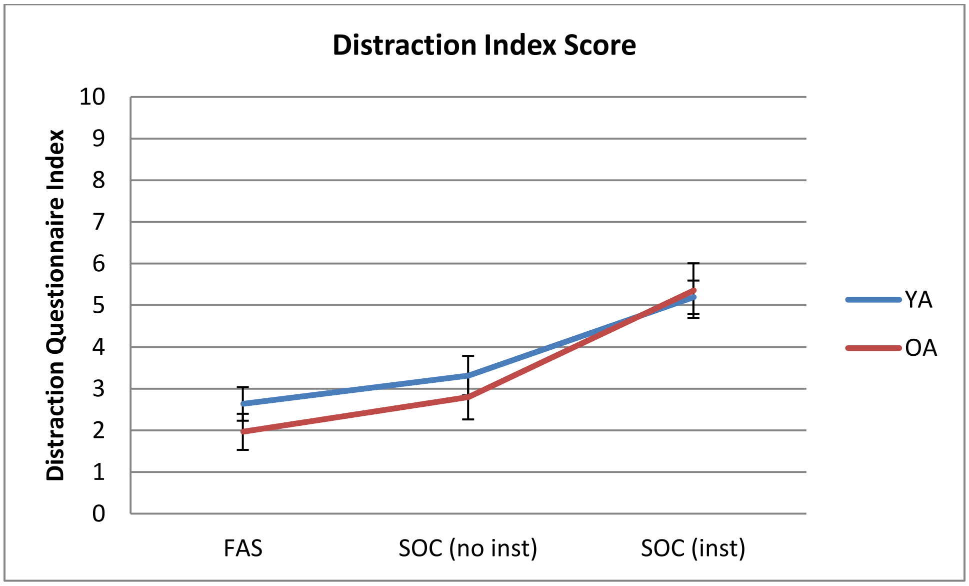

Figure 12. Index score on the intentional distraction questionnaire by age group and recovery condition. YA FAS n = 40, SOC (no inst) n = 38, SOC (inst) n = 38; OA FAS n = 31, SOC (no inst) n = 30, SOC (inst) n = 31.

Discussion

Age-related changes in use of distraction

The current study sought to determine the nature of age differences in recovery following a negative emotion induction in three different recovery conditions. It was expected that some recovery conditions would demonstrate age-related improvement in emotion regulation, but that other conditions might put older adults at a disadvantage (outlined in hypotheses 1 through 3). No age differences emerged in emotion regulation success, in terms of the degree to which participants' emotions improved during the recovery period, disconfirming the general expectation that older adults may improve or struggle with distraction in some contexts. Instead, older and younger adults appeared to regulate with roughly equal efficacy in the current set of conditions.

However, there were some age differences in degree of lingering negative thoughts which may suggest that older adults were less capable of distracting themselves in certain contexts (though this did not translate to emotional outcomes in this study). Older adults experienced significantly greater negative mindwandering, lower distraction (rated in the SOC writings) and higher levels of rumination (in SOC writings) both when they were allowed to behave spontaneously and when they were asked to distract themselves. Further, although they demonstrated marginally fewer off-task thoughts when distracted by a distractor task, older and young adults demonstrated equivalent thoughts about the negative pictures, possibly suggesting an age difference in how effectively the distractor task blocks emotional thoughts relative to non-emotional ones. This general apparent increase in rumination in older adults, however, might be partially the consequence of the greater impact of the emotion induction on older adults, which is supported by the presence of correlations demonstrating that people who experienced a greater induction tended to have more negative thoughts generally and by the fact that using negative mindwandering as a covariate eliminates age effects in the spontaneous behavior condition. However, differential induction cannot explain all of the effects, leaving open the interpretation that when trying to limit negative thoughts, older adults may have more difficulty in distracting themselves and in benefiting from environmental distractors.

Rumination patterns in the spontaneous distraction condition were the most surprising and in contrast to expectations outlined in hypothesis 2. In that condition, multiple lines of research (past rumination research, positivity effect literature) suggested that older adults should ruminate less than young adults when both groups were allowed to behave as they liked. However, older adults actually ruminated more than young (or equivalently to young, when response to the emotion induction is included as a covariate). Why are the findings of the current study different from findings in other studies? There are several possible explanations. Research demonstrating reduced negativity effects in memory, even after equivalent attention to stimuli during presentation (Thomas & Hasher, 2006), suggests the possibility that older adults dwell less on negative information after it has been presented. However, it is possible that these effects are not caused by differences in continued thinking about the negative stimuli. And, in fact, despite finding age differences in our sample that suggest equivalent or greater rumination in older adults, I did find some evidence for reduced negativity effects in our memory data, with older adults demonstrating equivalent gist recall of neutral pictures but reduced gist recall of negative pictures (to be discussed more later).

The other literature supporting decreased rumination in older adults more directly addresses the issue of rumination by measuring self-reports of ruminative thoughts. In all of the research I found, however, measurement of people's tendency to ruminate relied completely on retrospective questionnaires (such as in McConatha et al, 1997; Phillips, Henry, Hosie, & Milne, 2006; Torges, et al, 2008). In the comparison in our sample of retrospective reporting and online probe reporting, it appeared that young adults' estimates of their own negative thoughts increased when they thought back over 3 minutes (retrospective reporting) relative to when they reported over the last 30 seconds (probe reporting). In many studies, the delays between the actual ruminative behavior and requests to retrospect are often much longer (because participants are asked about how they generally have been responding), which could magnify these effects even more. In our sample, interestingly, older adults reported the same rumination levels regardless of probe type, though that may not hold over longer delays. However, it does appear that retrospective reporting could potentially put young adults at a disadvantage by increasing their estimates of rumination. If that is the case, it may be that increased or unchanged rumination with age is the norm, and that the opposite findings have been the result of using retrospective reporting.

The lack of age differences in spontaneous rumination also may have some interesting implications for applying socioemotional selectivity theory. SST suggests that older adults typically place more value on emotionally meaningful outcomes whereas young adults are more willing to put resources and time into information-gathering, which often means young adults are more willing to tolerate negative experiences if they can also be learning experiences. However, SST does not imply that young adults *do not* value emotionally meaningful outcomes or favor emotion regulation in some circumstances. The nature of the stimuli in this study or the recovery paradigm may have been such that it did not differentially motivate older and young adults. The stimuli, while disturbing, were not necessarily particularly novel or informative. In fact, many participants spontaneously reported having seen lots of pictures like these (on the news, etc). Once the pictures were gone and participants were no longer instructed to pay attention to them, motivation to continue ruminating about them may have been quite low for both age groups. Consequently, both young and older adults may have prioritized emotion regulation to some degree (and therefore limited rumination and improved affect in all conditions). This explanation should be examined in future studies by using emotion inducing stimuli that more directly address the hypotheses of SST, such as interpersonal stimuli (e.g. simulating an argument or task failure for participants). According to SST, older adults should be more likely to prioritize emotional goals in these situations, whereas young adults should prioritize information-related goals and allow themselves to keep ruminating about the negative incident. If this is the case, then age-related changes in rumination about negative instances may exist, but they may be specific to certain circumstances, not to all opportunities to regulate emotions. Empirically establishing this distinction is important for understanding the limits of SST in predicting emotion regulation behavior.

In the self-distraction condition, even accounting for the differential emotion induction did not eliminate the age difference in rumination, suggesting that older adults were less able to limit negative thoughts when both age groups were motivated to do so (consistent with one possibility mentioned in hypothesis 3). This is most consistent with research suggesting that older adults may have more difficulty in inhibiting previously-attended-to information (Hasher & Zacks, 1988). Older adults may be less effective at using self-initiated distraction to recover from emotion inductions, possibly because they are less able to direct their attention away from previously relevant stimuli onto thoughts more consistent with their current goals (regulation). It is also possible that young and older adults use slightly different strategies when asked to distract themselves, and that the strategy chosen by older adults is somewhat less effective at constraining thoughts. Alternative strategies that may have been used in this condition will be discussed later in the discussion. Although increased rumination in older adults did not translate to decreased emotional recovery in this study, it does give a glimpse of a situation where older adults may be at a regulatory disadvantage compared to young adults. The results also disconfirm the opposite possibility: that older adults might experience an increase in how effective they are at using distraction.

Based on the marginal age-related decrease in rumination about non-emotional stimuli, it seems possible that older adults can be more distracted by a distractor task (consistent with Smallwood et al’s, 2002, expectations). However, no age difference emerged when comparing rumination about negative thoughts, which might suggest that older adults’ attention is more captured by the negative stimuli, and increased distractibility of older adults does not extend to distraction from emotional thoughts. This finding may also be due to inhibition changes, which make it more difficult for older adults to eliminate previously salient stimuli from attention, even though it is important to redirect attention to the ongoing FAS task. In that case, reduced cognitive resources and inhibition deficits do not seem to be benefiting older adults who are trying to distract themselves (inconsistent with one possible expectation laid out in hypothesis 1 based on Smallwood et al's 2002 work). Instead, it appears that age-related cognitive changes may help distract older adults from non-emotional stimuli, but provide no special benefit for emotional stimuli (consistent with alternative hypothesis outlined in hypothesis 1, which expected inhibition deficits to interfere with the impact of distractor tasks). It is also possible that in the right situation, with extremely strong stimuli that are particularly attention-capturing, age differences in favor of young adults could emerge. It is also important to note, however, that older adults did have a stronger response to the negative induction, which may have also made their negative thoughts more salient than they were for young adults. Future research should examine contexts with age-equated emotional reactivity. It should also investigate situations with emotion inductions of various strengths to see if age-related differences may differ based on salience of the stimuli. Based on the explanation suggested here, I would expect that older adults may ruminate less than young with very mild stimuli, equivalently with moderate stimuli, and more than young adults with strong stimuli. When regulatory load is very high, older adults may be less able to benefit from environmental distractions during recovery.

In summary, older adults appear to ruminate more (and distract themselves less) than young adults during a recovery paradigm. This is in contrast to the possibility that they are more motivated or likely to distract themselves spontaneously (hypothesis 2), are more practiced and therefore effective at using distraction (one alternative outcome in hypothesis 3), and benefit more from their own cognitive decline when distractors are available in the environment (one alternative outcome in hypothesis 1). I also suspected that cognitive declines might be an asset when people are distracted by a distractor task, but a liability when people are self-distracting, but in this study cognitive declines appeared to be a liability in both cases.

Relationship of negative thoughts to emotional outcomes

So far, I have discussed age differences in degree of negative thoughts in terms of success with distraction. However, it is crucial to note that age differences in degree of negative thoughts did not translate to age differences in actual emotional outcomes. Both age groups regulated to a similar degree within each condition. Therefore, actual *regulation* success did not vary in this study for the two age groups, though I did find some evidence suggesting possible age differences in ability to use distraction to limit negative thoughts. Similarly, although there were differences in negative mindwandering between the two SOC conditions, there were no differences in degree of emotion down-regulation in these two conditions. When comparing age groups and conditions, it does not appear that degree of negative mindwandering always translated to degree of regulation success. However, degree of negative mindwandering did correlate with degree of regulation success, as measured by reductions in all three measures of affect (NA, PA, and valence), and this relationship did not vary with age group. So, negative mindwandering was important for regulation success, but for some reason did not manifest in differences in emotional outcomes between age groups or conditions.

Possibly, the impact of negative mindwandering on regulation success between various age groups and conditions was present, but was relatively weak and difficult to detect. Visual examination of differences in recovery between the two SOC conditions, for example, seems consistent with this explanation. It is also possible that negative mindwandering better predicts other kinds of recovery metrics, such as time-to-recover. Groups with lower mindwandering, for example, may recover more quickly than those with greater negative mindwandering, even though by the end of three minutes, the two groups have recovered to the same degree. Unfortunately, our study did not have data that could address this possibility. Given the clear relationship between negative mindwandering and regulation success using individual differences measures, I suspect that future research with larger groups of people and other metrics may find that the age and condition differences in negative mindwandering do relate to regulation success in some way.

Tracking negative mindwandering and emotional outcomes for longer periods of time may have also provided important information about differences in regulation success. In Larcom and Isaacowitz (2009), young participants experienced rebounds in negative affect at longer intervals, despite regulating successfully over short intervals, possibly because they used regulation strategies akin to thought suppression. Apparent lack of differences in emotional outcome between conditions or age groups over short intervals may not be obtained over longer intervals, if degree of negative thoughts shifts with time.

Comparing different regulation conditions

Interesting and not hypothesized regulation differences emerged between conditions. First, having an external distractor task appeared to be the most effective way to down-regulate emotions during recovery, as it resulted in the most emotional recovery and in fewer negative thoughts than the uninstructed SOC condition. The self-distraction group appeared to be the second most effective, with lower negative mindwandering than the spontaneously behaving group, although their emotional down-regulation was not different. It makes intuitive sense that trying to regulate emotions may result in better outcomes than spontaneously responding (where some participants may choose to regulate whereas others may not). The difference in regulation between the distractor task and self-distraction is also interesting.

Improved emotion-regulation success in the FAS condition relative to the self-initiated distraction condition (instructed SOC) is interesting because it suggests that the strategy people use when self-distracting is different in some way from having another task to focus on. Closer examination suggests one possible and important difference in these two conditions. In the FAS condition, people's thoughts were naturally drawn away from the negative pictures because they had to focus on something else (the FAS task) to be successful. In the instructed SOC condition, people initiated their own strategies, and it appears there may have been two basic types of strategies chosen by participants, based on rudimentary examination of the SOC writings. One set of participants seemed to limit negative thoughts by giving themselves an alternative goal, such as by planning an essay they had to write later or thinking about what items they were going to pack for vacation. This very goal-oriented thought style may be very similar to completing the FAS task, in that participants choose to devote their resources to a specific, different task. The other set of participants seemed to mindwander randomly, flitting from one type of thought to another (such as first reporting they are thinking about the color yellow, then what is for lunch later, then some song that they heard earlier, then how that reminds them of a friend they had in high school). This type of uncontrolled thinking may reflect that participants are using a strategy that is more like thought suppression than distraction. Rather than intentionally replacing negative thoughts with a specific set of alternative thoughts (as in distraction), participants may instead think about whatever comes to mind while specifically trying *not* to think about negative thoughts related to the pictures. In Wegner's thought suppression research, attempts to block thoughts are often associated with having more of the unwanted thought later (Wegner, Schneider, Carter, & White, 1987). He suggested this ironic effect was the product of an unconscious process that kept monitoring for the to-be-suppressed item in order to keep it out of consciousness, which can actually make the unwanted thought more accessible. The set-up for Study 1 may have also inadvertently exacerbated this problem by repeatedly reminding participants of the negative pictures during the mindwandering probes. Participants who were using a suppression-like process may then have been more likely to continue ruminating, compared to those who were actually using a more distraction-based method. And, in fact, Wegner finds that people who are given something else to focus on (such as in the FAS task or for the participants who naturally choose their own goal), have less of an ironic effect of suppression. Differences in regulation success between these two conditions might be the product of some participants in the self-initiated group choosing a less effective way to limit thoughts about the negative pictures. This might be explored in the future by creating another coding scheme meant to capture how goal-oriented participants' thoughts were in the instructed SOC condition. It might also be interesting to do follow-up studies with some instruction manipulations meant to encourage more distraction-like or more suppression-like strategy choices and examining the differences in outcome. The differences in performance between these two conditions also suggests that it is important for researchers to think more about the relationship of the similar constructs of distraction and suppression to see how they are different and how they relate to each other.

It is also possible that older and younger participants used different regulation strategies when asked to self-distract, and older adults may have chosen the one that is less effective at limiting negative thoughts (and therefore experienced more negative mindwandering in the instructed SOC condition). Whereas young adults may have selected a strategy of giving themselves an alternate goal to distract themselves, older adults may have selected a strategy more akin to thought suppression, which ironically can increase thoughts about the to-be-avoided information. Based on prior research, though, this would be somewhat unexpected. Larcom and Isaacowitz's research (2009) seemed to suggest the opposite—that young adults may be more likely to use thought suppression and suffer later consequences, such as a rebound in negative affect at a later time point. This interpretation of their data is further supported by Lambert et al (2013), who found evidence that older adults experience less thought rebound during suppression attempts. However, explicitly asking participants to regulate emotions in the current study may have encouraged selection of different regulation strategies, and even though older adults may evidence less negative impact of suppression, their use of suppression may still be less successful than use of distraction (if there is in fact an age difference in strategy choice). Future examination of strategy selection by young and older adults will be needed to resolve this question.

Regardless of mechanism, it appears that the most effective way to regulate one's emotions when trying to recover from a negative experience is to find another absorbing task to do.

Intentionality and cognitive requirements of distraction

The current study also sought to examine automaticity of distraction—both in terms of whether it requires cognitive resources and whether it must be engaged in intentionally. As expected (hypothesis 5), participants who were asked to self-distract reported higher levels of intentional self-distraction. Participants who were distracted by a distractor task did not report high levels of intentional self-distraction, despite clearly being distracted by the task, which does demonstrate that intention is not a necessary part of being distracted, but does not mean that self-distraction was deployed automatically (but instead, it was probably driven by situational demands). Participants who were allowed to react spontaneously, however, were less effective at limiting negative thoughts and also did not report high levels of intentional self-distraction, and there was no age difference in this pattern. This is in contrast to the expectation (hypothesis 5) that, when allowed to behave spontaneously, participants might regulate successfully without intentionally deploying regulation strategies (especially for older adults, if they have begun to deploy emotion regulation strategies more automatically), as expected in hypothesis 5. Instead, it does not appear that either young or older adults deployed distraction strategies automatically when allowed to behave spontaneously—or if they did, they deployed strategies less effectively than when they intentionally tried to self-distract.

The relationship of intentional distraction and distraction success could also be measured using an individual differences approach. Across conditions, intentional use of distraction did not correlate with two objective measures of distraction (negative mindwandering and emotional outcomes), which could have two causes. First, there may be no relationship because the score is not measuring intentional distraction effectively. Instead, participants may have answered the questionnaire based on what they knew they were supposed to be trying to do (with participants who were told to self-distract rating their attempts as greater than those who were given no such instruction). However, the lack of relationship within each condition would seem to undermine this explanation (I would still expect to see a correlation between ratings of intention and success within each condition). Alternatively, there may be no relationship because some participants *were* automatically deploying distracting successfully and others were intentionally self-distracting but were unsuccessful. There was no data, however, that suggested any age differences in these patterns, meaning that older adults did not evidence more automatic or unintentional distraction, as might be the case if distraction had become deployed more automatically for them with practice.

Before examining the cognitive resource requirements of distraction, it is important to establish that distraction was actually necessary or beneficial to recovery in this paradigm (i.e. people do not recover naturally without having to use distraction at all). It does appear that participants actually recovered more effectively if they were given an emotion regulation strategy to deploy (either through intentional self-distraction or a distractor task that was provided by situational factors). Although people in the spontaneous condition do improve in emotional outcomes, they improve the most slowly and continue to ruminate about the negative pictures to a greater extent than those in other conditions. This suggests that recovery does not appear to be something that happens completely independently of some form of regulation (whether that regulation is intentional or driven by situational factors), or if it does happen, it is a slower and less effective way to recover. This distinction is important because it means that deployment of a regulation strategy does impact the path of recovery, and therefore there is potential to need cognitive resources to enact these regulation strategies.

In examining cognitive resource requirements, our evidence is mixed. On one hand, age differences in ability to control negative thoughts seem to suggest that older adults' inhibition issues (attentional deficit) may impair ability to self-distract and to be distracted by an ongoing task when the stimuli is strong (though this result could be caused by differences in induction between groups or the way participants select strategies when self-distracting), as hypothesized in one alternative outcome in hypothesis 4. On the other hand, our structural equation models suggested that there was no relationship between cognitive resources and either emotional outcomes or negative mindwandering, which would be consistent with successful distraction being independent of cognitive resources (also a hypothesized possibility in hypothesis 4). However, there are a few reasons to regard the SEM results with caution.

First, the study deals with very small sample sizes (from 20 to 140 depending on the model). This likely limits our ability to pick up relationships in the models. Degree of negative mindwandering (and emotional outcome) may also be related to many other variables (other than cognitive resources) and this may dilute the relationship between cognitive resources and these two variables. For example, variables like base tendency to ruminate, personality factors like neuroticism, general motivation to regulate, motivation to do a task you have been given by an experimenter (like the FAS task), and even factors such as whether you find the FAS task to be fun or tedious are all factors that might impact your tendency to ruminate and degree of regulation, independent of your cognitive resources. For example, someone who enjoys the FAS task or who is especially motivated to do well on the task, might put more effort into that task, which may influence how distracted they are by it. Likewise in the instructed SOC task, someone who is highly self-motivated to down-regulate emotions might put more effort and resources into this effort compared to someone who is only trying to regulate to comply with the experimenter. The degree to which you devote resources to the regulation task (or other tasks) is likely to depend on variables in addition to the degree of resources you have to devote to the task. Therefore, there might be no relationship between the cognitive variables and other variables, not because cognitive resources are not required to regulate emotions but because your level of cognitive resources and the way you allot your cognitive resources may not be synonymous. In a large enough sample, these factors may not be an issue, but in a small sample they could overshadow existing relationships between cognitive resources and other variables.

Next, it is possible that the tasks chosen for this study put little load on participants' cognitive resources. Possibly, with more personally relevant or salient stimuli, participants might evidence more need for cognitive resources to avoid thinking about the items. For example, staging an altercation (or giving participants negative feedback about their study performance) or having participants ruminate for a while about a personal conflict in their lives might create a greater regulatory load that would draw on resources. If there continued to be no relationship between cognitive resources and emotion regulation with a greater load, I might be more confident that distraction during recovery is simply not particularly resource demanding. It is also possible that emotion regulation during recovery does draw on cognitive resources, but the variables I chose to represent cognitive resources were not the relevant ones.

Positivity effect in memory

The study did not explicitly seek to investigate positivity effects in memory, but a positivity effect did emerge in the gist recall data, which provides an opportunity to consider mechanisms for the positivity effect in this study. It is sometimes posited that positivity effects in memory are caused by older adults' reduced dwelling on the negative stimuli between presentation and memory test (Thomas & Hasher, 2006), which our study is equipped to examine. As mentioned earlier, there was no age difference in memory for the gist of neutral pictures, but older adults remembered fewer negative pictures than did young adults. The positivity effect emerges even though the evidence I have suggests that older adults actually thought more about the negative pictures, at least for the three minute interval that I measured their negative mindwandering. Charles et al (2003) found similar results in their study, in which older participants attended more to negative pictures but did not display increases in memory for the pictures. Combined with their results, our results seem to suggest that positivity effects in memory are not always caused by differences in ongoing rumination.

Interestingly, negative mindwandering *did* correlate with gist recall (and other memory variables), but only for young adults. Older adults' degree of negative mindwandering was not significantly correlated with later memory performance. This finding is a bit perplexing: more thinking about a stimulus should lead to better memory for it later. It is possible that older adults who continued thinking about the pictures thought about them in ways that did not help them create gist memories (such as having perseverative thoughts about specific pieces of pictures but not the entire gist, or thinking about negative pictures in a more general way, such as generally thinking about violence and therefore not encoding specific enough gist information to receive credit for recalling the gist later). It is also possible that the locus of the positivity effect in memory is at retrieval or encoding. If older adults paid less attention at encoding, this may have decreased later memory for the stimuli, even though some stimuli were processed and ruminated about. Similarly, even if older adults paid attention to the stimuli and ruminated about it, differences in goals at retrieval may have led to retrieval biases that limited the number of negative pictures recalled. It is possible that memory performance in older adults would be better predicted by emotion regulation goals (or future time perspective), rather than degree of rumination.

I also found evidence that arousal *during* picture presentation correlated with memory performance in opposite ways for the two age groups, which may help explain the positivity effect as well. For young adults, greater emotional arousal was associated with greater recall (and recognition) of pictures, but for older adults, greater arousal was associated with worse memory performance. This finding can be interpreted in several ways. First, the impact of arousal on memory may be different for older and younger adults. Some research demonstrates that arousal can benefit memory for young adults but either is not associated with memory for older adults or seems to impair older adults (Grühn & Scheibe, 2008; Nashiro & Mather, 2011; Riediger et al, 2014). Even in young adults, high enough arousal can disrupt memory (Eysenck, 1976; Gavazzeni et al, 2012), and this impact appears to be related to levels of anxiety (Eysenck, 1985). It is possible that at relatively low levels of arousal, increases in arousal improve memory performance but that at higher levels of arousal, increased arousal impairs memory, consistent with an inverted-U function such as that described by Yerkes and Dodson (1908) in a non-memory context. Older and younger adults' arousal in this study may be operating at different points on this inverted-U function. Also, given that older adults seemed to have a stronger emotional response to the pictures, their worse memory for negative pictures later may be the result of too-high arousal at encoding.

Lower IBI can also result from lower orienting affect. The negative correlation in older adults may be the result of older adults who orient less to the pictures later remembering them less well than older adults who orient more to the pictures. Older adults find arousal more aversive, and therefore sometimes avoid arousal when possible (Shiota & Neufield, 2014), and less attention to the stimuli at encoding could certainly impair memory for it later on. For young adults, however, the correlation may be primarily driven by emotional arousal rather than orienting effects.

It is also possible that the differing directions of the correlations between IBI and memory in the two age groups is the product of the types of thoughts each age group favors when highly aroused. Highly aroused young adults may be concentrating on aspects of the pictures that are likely to improve later memory, such as details of the emotional parts of the pictures. Older adults, however, may favor trying to orient away from negative parts of the pictures (or orienting away from the pictures entirely) when they find themselves highly aroused. This attempt to change attention might impair later memory. It is also completely feasible that multiple mechanisms are acting at once, with less attention leading to less memory *and* higher emotional arousal impairing memory. In either case, it appears that at least some of the positivity effect in this study may be due to processes that are occurring at encoding rather than processes intervening between encoding and retrieval (or at least in addition to them).

In summary, positivity effects in memory might not reflect differences in rumination about the negative stimuli, but may be more appropriately related to factors like retrieval biases, differences in the impact of arousal on memory for older and young adults, or changes in how older adults attend to negative stimuli at encoding. In the current study, future analysis can be conducted using eyetracking data to investigate whether reduced orienting (reflecting changes in motivation) might help explain the current positivity effect findings.

Limitations

The study had some limitations including issues with the physiology and memory variables that warrant some discussion.

Physiology findings. The physiology findings were not discussed in the above section because they were of limited use in assessing the hypotheses. The physiology equipment was functioning and did find evidence for an induction effect. For example, there was a classic orienting response, with decreased IBI and increased SCR in response to the pictures. The orienting response was also greater to the negative pictures than the neutral ones, consistent with emotion induction. Further, self-rated strength of emotion and negative affect correlated with IBI at induction and skin conductance level correlated appropriately with strength of emotion, valence, and positive affect. The lack of change from baseline to induction in each variable precluded the use of physiology data in looking at time-to-recovery because I could not calculate time to return to baseline when baseline was not left during the induction. The lack of change from baseline to induction, however, is not surprising. As mentioned before, physiological variables are multiply determined. Orienting and arousal responses often cause conflicting responses. IBI increases in orienting effects but decreases in response to arousal. Therefore, changes in IBI are based on the balance between these two opposing forces. In the case of this study, the orienting response appears to have overwhelmed the response due to emotional arousal. Similar findings have been found in other studies of emotion and are not uncommon (for general reviews see Andreassi, 2006; Cacioppo, Berntson, Klein, & Poehlmann, 1998; for examples of this outcome in the literature see Demaree, Schmeichel, & Robinson, 2004; Fredrickson & Levenson, 1998). Some theorists also posit that different emotions may be related to different physiological profiles, with not all emotional arousal being associated with the same activity in each measure (Levenson, 1992; Sinha, Lovallo, & Parsons, 1992).

Unfortunately, not having the time-to-recovery variable limits our ability to see differences in regulation between age groups and among conditions. With this variable, I may have been able to see changes in time to recover among age groups (such as more rapid regulation seen in Larcom and Isaacowitz, 2009) or differences between conditions that could not be differentiated in self-report.

The physiology variables did allow us to see an interesting difference in arousal among conditions. PEP length in the uninstructed SOC condition increased from the neutral to negative trial, whereas there were no changes in the other two conditions. This is consistent with greater arousal following practice in the FAS and instructed SOC conditions compared to the uninstructed SOC condition. The relationship of PEP to attention is not always clear, but differences in PEP arousal do suggest that practicing the uninstructed SOC task altered participants' emotions or attention in some way. Regardless of what participants were doing, it seems important to make sure that future studies take into account the impact that practice can have on later arousal. In this study, it may have been beneficial to give all participants practice with all tasks.

Memory findings. There were no effects in any memory variable that included differences between conditions. Although our hypotheses (1 through 3) suggested that memory recall should differ among people who successfully distracted themselves (such as those in the FAS or instructed SOC condition), I found no support for this hypothesis between conditions (though I did find an overall correlation between negative mindwandering and memory outcomes). However, in retrospect, failure to find differences between conditions may not be surprising. Although I manipulated attempts to distract for a three minute period after participants viewed the pictures, there was no manipulation of how people paid attention during picture presentation or what they thought about for the next 23 hours before they were tested on picture memory. Constraints on thoughts about the pictures for those three minutes probably had minimal impact on memory for pictures 24 hours later, compared to participants' thoughts and experiences during the intervening time. I may have been more successful in finding memory effects if I had tested memory differences for pictures immediately following the recovery period.

Other limitations. The differential impact of the negative mood induction on the two age groups also complicated interpretations in this study. Although older adults appear to ruminate more than young adults, this may be at least partially explicable by the fact that they had a higher reaction to the induction and therefore more emotion to regulate.

Conclusions

There was minimal evidence in this study that older adults are better at distraction in a recovery paradigm (in terms of both thoughts about negative events and degree of emotional recovery). There were no age-related benefits in emotion regulation in any condition. If older adults were more motivated or capable of regulating using distraction (in this context at least), I found no evidence of it. There were also no age-related benefits or deficits associated with being exposed to a distracting task. In fact, the only age differences suggested that older adults may ruminate more about negative experiences, especially when both groups are trying to self-distract. However, differences in rumination did not translate to age differences in emotional outcomes, though rumination in general was correlated with emotional recovery. The current study does give some insight into some possible conditions where there may be age differences in use of distraction. Although I found no differences in emotional outcome, differences in ability to dampen negative thoughts may put older adults at greater risk for negative emotional outcomes, and differences in outcomes may emerge if future studies use alternative measures like time-to-recover.

STUDY 2

As reviewed in the introduction, it is unclear whether distraction requires resources for older adults, and hence, whether it might be a difficult or impossible strategy in some circumstances. In a depletion paradigm, young adults do not seem to be depleted by using distraction to regulate emotions (Sheppes & Meiran, 2008). However, older adults experience changes in ability to inhibit irrelevant information, which could make distraction more difficult. Older adults also experience declines in cognitive resources, which could limit their ability to use resource-demanding strategies. Further, studies using dual-task paradigms suggest that distraction may be resource-demanding for older adults (Mather & Knight, 2005). Based on this research, I expected that distraction would not have depletion costs (which occur only for tasks that draw on self-control) for young adults, but that it may for older adults. Study 2 investigated this possibility by examining depletion costs associated with distraction in both older and younger adults. By understanding whether distraction is resource demanding for older adults, researchers can better predict under what circumstances older adults might be able to use distraction to regulate emotions and when they might be better served using a different strategy. To further examine the pros and cons of distraction as an emotion regulation strategy, it was compared to reappraisal, another emotion regulation strategy that appears to have a different cost profile in past research.

Reappraisal involves altering the meaning of a stimulus or event so that it carries a different emotional meaning, such as thinking of a setback at work as a challenge so that it is less upsetting. Researchers have not clearly determined how reappraisal and distraction differ in terms of their resource requirements. Some studies suggest that reappraisal may be more demanding than distraction (Sheppes & Meiran, 2008).

Reappraisal causes greater depletion than distraction if both are enacted late in the emotion generation process (Sheppes & Meiran, 2008). It also relies on brain areas that are associated with cognitive control (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner & Gross, 2005), and the degree of success in reappraisal is directly related to activation of those areas (Wager et al, 2008). Further, degree of success in reappraisal is frequently related to other aspects of cognitive functioning, including cognitive control, suggesting that reappraisal may rely on control mechanisms (McRae, Jacobs, Ray, John, & Gross, 2011). Further, reappraisal happens slightly later in the emotion generation process (Gross & Thompson, 2007), and therefore people must alter processing that may already be underway, which may be more resource consuming than simply trying not to attend to something (as in distraction).

Different types of reappraisal may be differentially resource demanding. Shiota and Levenson (2009) suggest that detached reappraisal is more resource demanding because it requires a person to completely ignore the emotional aspects of a stimulus to change the meaning into something neutral, whereas positive reappraisal allows people to attend to the emotionally valenced stimuli. They find that older adults have more difficulty with detached reappraisal, possibly because of this difference in resource demands. On the other hand, young adults appear to have more difficulty with positive reappraisal, rather than detached reappraisal, possibly because they have more difficulty finding positive aspects of situations that appear to be negative. Older adults, who may have experienced being in negative situations that have positive outcomes more frequently than young adults, may have an easier time finding positive connotations when young adults may struggle to do so. For example, for a young adult the concept of death and dying may be very difficult to reappraise positively. For an older adult, who is more likely to have served the role of caretaker to parents, friends, or spouses, personal experience may suggest that death can be a release from pain, and therefore relieving rather than devestating. The actual resource demands of positive and detached reappraisal have never been examined, however, so it is unclear whether their demands may change with age.

Although some research seems to suggest that reappraisal is resource demanding (and perhaps more so than distraction), other researchers have conceptualized reappraisal as a strategy that has very low demand. Gross conceptualizes reappraisal as a very early-acting strategy, which stops the generation of negative emotion early on and prevents the need for further expenditure of resources to regulate emotions (Gross & Thompson, 2007). Further, as people age, reappraisal may not be as negatively affected by inhibition deficits, because reappraisal allows older adults to attend to emotional stimuli (which they may have difficulty ignoring). So, for people with inhibition problems, like older adults, reappraisal may be less demanding than distraction.

Resource demands of distraction and reappraisal have been compared only in young adults. Using a depletion paradigm, it was demonstrated that young adults were more depleted by reappraisal than distraction, but this study was conducted by asking participants to use these strategies after they had already been experiencing the emotion for some time. It is unclear how the strategies compare when they are enacted at the onset of the stimulus. However, it seems possible that distraction may become more costly as people age, making it a problematic strategy for older adults in some situations, and that at least some types of reappraisal may decrease in resource demands, making them particularly good choices for older adults.

Reappraisal also differs from distraction in terms of consequences for emotions long-term. Whereas reappraisal appears to alter the impact of the negative stimulus long-term (MacNamara, Ochsner, & Hajcak, 2011; Thiruchselvam et al, 2011; Walter et al, 2009), distraction only provides emotional relief as it is being enacted and not when a person encounters the same stimulus again later (Thiruchselvam et al, 2011). However, when enacted relatively late in the emotion generation process, such as when people wait to begin regulation until an emotion has already been generated, reappraisal appears to be somewhat less effective than distraction (Sheppes, Catran, & Meiran, 2009; Sheppes & Meiran, 2007), suggesting that distraction may be a better choice at this time point.

Distraction and reappraisal also have different consequences for memory for events that are underway during the regulation attempt. For example, reappraisal does not negatively impact memory (Richards & Gross, 2000) and potentially could improve memory as it encourages deeper processing of the stimulus. Distraction, however, does impair memory for information encountered during the distraction attempt (Richards & Gross, 2006). In situations where remembering the stimulus for later may be important, reappraisal may allow older adults to both attend to the stimulus and meet their emotion regulation goals. Age differences in the impact of distraction and reappraisal on memory are unclear. It seems likely that distracting oneself from a stimulus would impair memory for both age groups and elaborative encoding that comes with reappraisal may improve memory for both age groups.

However, to the extent that different age-groups are differentially capable of each strategy, memory patterns may vary. Arousal is likely to impact memory (Payne et al 2006), so in conditions where one age group down-regulates arousal more effectively, that group may have lower memory performance. On the other hand, successful reappraisal may be associated with deeper processing of meaning, and so successful reappraisers may better remember information. Successful distractors are likely to remember less information than others because they will not have paid attention to it. To the extent that the two age groups and different conditions differentially encourage elaborative processing and result in greater arousal compared to other conditions, memory is likely to differ, though it is unclear how arousal and elaborative processing might interact. Figuring out which conditions are conducive to later memory for events, however, could have interesting implications for which strategies are best suited to certain contexts.

Study 2 compared the costs of reappraisal and distraction to determine the pros and cons of these strategies and shed light on when certain strategies may be more beneficial than others. I employed a depletion paradigm, as described in the introduction, where participants were asked to regulate their emotions through either detached reappraisal, positive reappraisal, or distraction or asked to experience their emotions. Then, a self-control requiring task was completed (the N-back task). Performance on the N-back task was measured to estimate the degree of self-control resources invested into the emotion regulation task. Further, participants were called 24 hours later and asked to recall as many negative pictures as possible, providing an indicator of the memory consequences associated with each strategy. In addition to behavioral measures, I also measured physiological arousal. These measures have the added benefit of allowing us to confirm self-reported emotion regulation success using a measure that is not biased by demand characterstics. In addition, physiological measures gave us the opportunity to look for responses consistent with challenge and threat appraisals. Eye-tracking was also used to help assess whether participants were behaving in ways consistent with distraction when they are asked to distract themselves.

Hypotheses

Hypothesis 1

I expected older adults to successfully regulate in the positive reappraisal and distraction conditions, as found previously. However, older adults were not expected to successfully regulate in the detached reappraisal condition, consistent with prior findings. Successful regulation reflects the ability to minimize self-reported negative affect and physiological arousal associated with negative emotion. Therefore, older adults in the positive reappraisal and distraction conditions were expected to have significantly lower self-reported negative affect/higher positive affect and lower emotion-related physiological arousal than older adults in the experience or detached reappraisal condition.

Hypothesis 2

Young adults were expected to successfully regulate in the detached reappraisal and distraction conditions. However, they were not expected to successfully use positive reappraisal. This would manifest in young adults in the detached reappraisal and distraction conditions having significantly lower self-reported negative affect and physiological arousal than those in the positive reappraisal and experience conditions. These expectations are consistent with prior research.

Hypothesis 3

Given older adults' success with distraction and positive reappraisal in other studies, it was expected that these strategies would be less depleting than detached reappraisal, which older adults may fail at because of its greater reliance on cognitive control. Distraction may be depleting for older adults, compared to both positive reappraisal and the experience condition, because distraction may become more difficult as ability to inhibit irrelevant information declines. However, inhibition deficits are not accepted by all researchers, in which case older adults may not be depleted by distraction (as found with young adults). It was unknown whether positive reappraisal would draw on self-control resources (and therefore cause depletion) or not.

Hypothesis 4

Consistent with prior research, it was expected that there would be no depletion costs associated with distraction for young adults. Further, depletion costs associated with detached reappraisal were expected to be minimal, given young adults' success enacting this strategy, though it was possible that some depletion costs would emerge. Positive reappraisal may be difficult for young adults, as evidenced by their difficulties enacting the strategy, and therefore was expected to be costly for them to implement, perhaps more so than the other strategies.

Hypothesis 5

Distraction was expected to impair memory for emotional pictures for both age groups, relative to other strategies. To the extent that one group is more effective at distracting themselves, that group should have proportionally worse memory performance, but it was unclear which age group (if either) may be more effective at using distraction in this context.

Hypothesis 6

It was expected that positive and detached reappraisal may improve memory for items relative to the experience condition because these strategies may encourage deeper processing of stimuli, but which type of reappraisal most assists memory was likely to vary by age group. Higher arousal and elaborative processing should improve memory, but may work in opposition to each other in certain conditions. For people who successfully down-regulate emotions in a reappraisal condition, arousal was expected to be low but elaborative processing would be high. Therefore, it was difficult to estimate how reappraisal conditions would impact memory for each age group, even with hypotheses about how each condition would impact arousal and elaborative processing.

Hypothesis 7

I also examined the physiological reactivity patterns for evidence of threat and challenge reactions. Based on our other hypotheses, it seemed most likely that a challenge reaction would emerge in older adults who were positively reappraising or young adults who were successfully using detached reappraisal. This may occur because in these conditions, participants may be exerting effort to follow instructions, but be confident in their ability to perform the regulation task. For older adults who were using detached reappraisal and young adults who were using positive reappraisal, physiological patterns may be more appropriately characterized as threat reactions.

Methods

Materials

N-back task. During this task, participants were asked to respond whether the number (1-9) currently presented on the screen matches the number that was presented N items back. Answers were made using two keys on the keyboard and both accuracy and reaction time were recorded. Items were presented for 500 ms with a blank screen lasting 2500 ms in between each item. The program consisted of 33% targets (items that *do* match the item N screens before; Gray, 2001; Huxhold, Li, Schmiedek, & Lindenberger, 2006; Scheibe & Blanchard-Fields, 2009). One benefit of this task is that it does not appear to be influenced by negative emotion (Bless, 2003). It is also consistent with the conceptualization of self-control included in the depletion paradigm.

I selected the N-back task for several reasons. First, in Senesac and Blanchard-Fields (2012), which used the Stroop task, depletion effects emerged relatively late in the block of Stroop trials, possibly because it took a while for depletion effects to build to the point of interfering with performance. A very challenging task such as the N-back, which should require greater cognitive resources, was expected show more pronounced depletion effects which would be easier to detect. Second, I had concerns about age differences in the difficulty of the intervening task. Specifically, if a task meant to measure depletion is more difficult for a particular individual (or an age group in general), that task may be more sensitive to depletion effects for that person. In the N-back task, I manipulated the difficulty level of the task by manipulating how many numbers a person must remember, and this allowed us to roughly equate N-back difficulty for each person. Each individual's N-back was selected based on their N-back performance at a preliminary session.

Participants completed 3 different N-back sections. During the first lab session, they completed a practice N-back program that explained the instructions for each N-back from a 1-back (does the current item match the last item?) to a 5-back (does the current item match the item presented 5 items ago?) and gave the participant a chance to practice each and ask questions. Each practice section included 7 items. Participants then completed the "calibration" version of the N-back, in which they completed 28 trials of the 5-back, 4-back, 3-back, 2-back, and 1-back in descending order. They then do another section of 28 trials of each version, again in descending order. This was intended to give us plenty of trials of N-back so that I could determine which version to use at the second session. Using performance on the N-back calibration task, I selected the N-back version for each participant that was completed with close to 80% accuracy. If participants did not perform within 5% of 80% accuracy on any version of the N-back task, then they were not be used in the second part of the experiment. This eliminated 8 participants out of 239 who completed session 1. During the second session, participants completed only the one version of the N-back selected based on performance during the first session. For example, someone who was 80% accurate on the 4-back during the first session did only the 4-back during the second session. The N-back task during that session consisted of 154 items and lasted approximately 7.5 minutes.

Pictures. Participants were exposed to another set of pictures selected from the IAPS database (Lang, Bradley, & Cuthbert, 2005). This set of pictures included 13 pictures with negative content that were specifically selected because their content lends itself to positive reappraisal, and they were thematically similar to the picture presented in Study 1. Each picture was presented for 15 seconds for a total of 3 minutes of picture presentation.

Emotion rating form. The emotion rating forms described in study 1 were also used in this study.

Psychophysiological measures*.* The same physiological measures described in study 1 were used in this study.

Recognition memory questionnaire. This questionnaire was created for this study and consisted of 58 questions with four or five answer choices each. The questionnaire was modeled off of questionnaires used by Payne and colleagues (2006) and Richards and Gross (2000) to assess recognition memory for emotional stimuli. The questionnaire briefly described each picture (pictures from both study 1 and study 2), and then asked participants to try to remember that picture. Then, participants were asked two to three questions about the picture that was just described. For each picture, one question tested memory for a detail that is central to the picture, which was defined as a detail about the emotional content of the picture that attracts attention. For each picture, another question tested memory for peripheral detail, which was defined as some element of the picture that was not related to the emotional content of the picture (such as a background detail) and which would not change the meaning of the picture if it were removed. This definition of central and peripheral detail is similar to one used by Payne and colleagues (2006). Participants were encouraged to answer the questions only if they felt confident in their answer and were otherwise encouraged to answer "I don't know".

Procedure

Before they came into the lab, participants received a take-home packet that includes questionnaires including a demographics form. Most of these questionnaires were not be relevant to this dissertation. Participants were asked to read and complete an informed consent form before completing the questionnaire packet. They were asked to bring the consent form and take-home packet with them to their first lab session.

The first lab session consisted of cognitive tasks. When each participant arrived at the lab, his or her consent form was checked by the experimenter. They then completed the cognitive tasks for both Study 1 and Study 2. After participants left, the experimenter analyzed their data to determine which N-back test would be used for that participant during the second session.

The second lab session was conducted at least 3 days later (but no more than one week), to allow participants a break from the N-back task but to keep them roughly at the same level of recent practice with the task. Participants were hooked-up to the psychophysiology measures, the eyetracker was calibrated, and then the session began. They first completed the tasks from study 1, including the neutral picture section and the section of negative pictures where participants watched the pictures and allowed themselves to experience their emotions. Reaction to the negative set of pictures can be used as a comparison condition for the negative set of pictures in which some participants were asked to regulate emotions. After the study 1 tasks, participants were given the opportunity to take a break, and then continue on to the tasks that were relevant for Study 2.

Next, participants were told they would see another set of pictures but that this time they would be asked to follow specific instructions. The experience group was told: *While you are watching the pictures, please try not to regulate your emotions. Watch the pictures carefully, and try to let your emotions happen naturally without trying to get rid of them*." The positive reappraisal participants were told : *While you watch the pictures, please try to think about positive aspects of what you are seeing. Watch the pictures carefully, but please try to think about what you are seeing in such a way that you feel less negative emotion. For example, if you see a picture of a house on fire, you might think "It's good that people have insurance for this sort of thing."* Participants in the detached reappraisal condition were told: *While you are watching the pictures, please try to adopt a detached and unemotional attitude. As you view the pictures, please try to think about what you are seeing objectively. Watch the pictures carefully, but please try to think about what you are seeing in such a way that you feel less negative emotion. For example, if you see a picture of a house that is on fire, you might think "I wonder how this fire got started?"* Participants in the distraction group were told: *While you are watching the pictures, please try to distract yourself from the negative content of the* *pictures. Watch the pictures, but at the same time, try to think about something else that is not related to the picture content and that is emotionally neutral. For example, if you see a picture of a house that is on fire, you might think "What should I have for dinner tonight?"* The reappraisal instructions were adapted from Shiota and Levenson (2009).

After the regulation instructions, participants were given a chance to ask questions and then were asked to concentrate on a cross on the monitor while clearing their mind of thoughts and feelings for 90 seconds. Following this baseline period, a brief instruction reminder appeared on the screen for 5 seconds. Then, picture presentation began (3 minutes). Immediately following the pictures, participants filled out the emotion rating form again. They were then briefly reminded of the N-back instructions and completed the N-back task.

Following the completion of the experimental protocol, participants were asked questions meant to check whether they understood and followed the regulation instructions. The experimenter said, "While you were viewing the last set of pictures, I asked you to follow specific instructions. Tell me whatever you can remember about those instructions." After they respond they were asked, "What did you try to do in order to follow those instructions?" In order to get as specific responses as possible, participants were then asked, "Was there anything in particular that you remember thinking about or trying to do? For example, do you remember any specific thoughts you had during specific slides?"

Participants then complete several additional tasks intended to elicit positive emotions, which were not directly relevant to this protocol, but have the benefit of improving mood before participants leave the lab. They were compensated and debriefed.

Twenty-four hours following the second session, a follow-up call, which was scheduled in advance, was placed to the participant. If the participant did not answer the phone, a message was left, and follow-up calls were placed later that day and the first thing the next day. After 48 hours passed, the follow-up call was considered missing and no further attempts were made to contact the participant. The time delay between the session and interview were recorded so they could be used as a covariate. In the interview, participants were asked to recall as many pictures as possibly from their session. The experimenter began the follow-up call with a general question asking participants to think back to being in the experiment and remember as many pictures as possible. Once participants were given time to respond, the experimenter told them how many pictures they had described out of the 38 presented over the whole session (negative and neutral pictures presented in both study 1 and study 2). Then, the experimenter asked the participants to imagine being in specific parts of the experiment and reminded the participant what was happening, asking the participant for each section of the experiment whether they remember any more pictures from that part of the study. After this free recall procedure, the experimenter read aloud the recognition memory test and participants gave answers to each question. Finally, participants were thanked, debriefed, and compensated.

Results

Manipulation Checks

Emotion induction. To ensure that the pictures elicited an emotional response, separate 2 (age group) X 2 (trial type: neutral vs regulate) repeated measures ANOVAS were conducted using self-reported emotion measures as dependent variables[6]. The analysis was conducted on the experience group only, as other groups' regulation attempts may mask emotion induction.

In analysis conducted using NA as the dependent variable, there was a significant main effect of trial type $F(1, 53) = 302.229$, $p < .001$, partial eta square = .851, such that people reported higher NA after the induction, as expected (neutral NA: M = SE = ; regulate NA: M = 3.77, SE = .28). There was also a main effect of age $F(1, 53) = 6.742$, $p < .05$, partial eta squared = .113. Older adults experienced higher NA than YAs did (YA: M = 2.50, SE = .33; OA: M = 3.81, SE = .48). Both of these main effects were qualified by a significant trial type X age group interaction effect $F(1, 53) = 7.258$, $p < .01$, partial eta squared = .120. Young and older adults reported equal NA during the neutral pictures (YA: M = 1.82, SE = .32; OA: M = 3.03, SE = .54), but older adults reported significantly higher NA during the negative condition $t(53) = -2.940$, $p < .01$ (YA: M = 3.17, SE = .34; OA: M = 4.58, SE = .43). This suggests that the emotion induction was stronger for older adults than for younger adults, as was the emotion induction in the first study.

Analysis was also conducted using PA. No significant interaction effect or main effect of age was found. However, there was a significant main effect of trial type $F(1, 53) = 42.516$, $p < .001$, partial eta squared = .445, with PA decreasing during the negative induction. The last set of analyses was conducted using the valence question data. A significant main effect of trial type emerged $F(1, 53) = 101.395$, $p < .001$, partial eta squared = .657, with people reporting more negative valence after the induction. No

[6] Analyses were also conducted with self-reported emotion following the recovery period from study 1 as a covariate, in case that emotion induction predisposed older adults to have higher negative emotions. Including the covariate did not alter the results. This is consistent with older adults having similar levels of emotion to young adults following the recovery period in study 1.

interaction effect emerged, but a significant main effect of age was revealed F (1, 53) = 3.737, p = 12.361, partial eta squared = .189, with older adults expressing more positive valence over all, as is often found in studies of affect and aging.

Taken together, these results suggest a successful negative emotion induction, which appears to have been stronger for older adults, at least in terms of how it impacted their negative affect specifically.

Regulation instructions. It was also important to verify that participants tried to use the emotion regulation instructions given to them. Following the experimental manipulations, participants were asked to report 1) what they remembered about the emotion regulation strategy given to them, and 2) to give specific details about what they thought about in order to achieve their goals. Participants' responses were coded into detached reappraisal, positive reappraisal, distraction, and experience behaviors. Description of the coding process is available in Appendix F. Compliance with distraction instructions can also be assessed looking at gaze information from the eyetracker.

Results of strategy coding. The results of strategy coding can be seen in Table 2. In the positive reappraisal condition, 77% of participants gave at least one example of a strategy that could be categorized as positive reappraisal. In the detached reappraisal group, 65% evidenced using detached reappraisal. In the distraction group, 68% evidenced using distraction, and in the experience group, 79% did not describe using any strategy for at least some of the pictures.

The results of strategy coding suggest that some participants did not follow instructions. Other participants did use the strategy suggested to them, but also used another strategy in addition to it. Complete compliance was defined as a participant using only the strategy suggested to the participant. Complete compliance rates varied by condition, with detached reappraisal having the lowest complete compliance (36%), the experience condition having the highest (67.4%), and positive reappraisal and distraction having similar rates (63% and 61.3%, respectively). Complete compliance rates are calculated as percent of the total number of participants in a condition who had codable data.

Some participants partially complied with instructions by utilizing both the requested regulation strategy and another regulation strategy. In the detached reappraisal condition, for example, 34% of participants used BOTH detached reappraisal and another strategy. Therefore, it appears that a large portion of participants did use the strategy assigned to them, but many of them also used additional strategies, which could make depletion and memory data more difficult to interpret. Therefore, in addition to completing analyses based on assigned condition, some supplementary analyses were also conducted by splitting participants into groups based on their reported strategies. This did not appear to alter patterns of results, so final analyses are reported based on originally assigned groups.

Table 2. Coded outcomes based on original assigned condition (left) and age group (right).

		Assigned Conditions				Age Group		
		PR	DR	D	E	YA	OA	Total
Coded Outcome	PR	29	2	4	0	20	15	35
	DR	2	18	2	3	14	11	25
	D	1	9	27	2	26	13	39
	E	1	2	0	31	16	18	34
	Reappraisal-both	8	10	2	0	12	8	20
	All strategies	2	0	2	0	1	3	4
	Other combo	3	7	7	9	11	15	26
	Other strategy	0	2	0	1	0	3	3
	No data	6	4	7	5	15	7	22
	Not codable	1	3	2	2	7	1	8
	Total	53	57	53	53	122	94	216

Eyetracker results. It was expected that participants in the distraction condition should spend less time looking at the emotional parts of the pictures. To examine this, I analyzed gaze patterns using data from the eyetracker. Participants were only included in eyetracker analysis if the eyetracker could track their gaze during more than 25% of the picture presentation period[7]. Using this criteria required excluding data from 13 participants (of 197), and exclusion rates were similar in each cell (about 1 participant). There were no differences among conditions in percent of picture period that was trackable, but there were age differences, with older adults being less trackable.

There were 13 pictures presented to each participant. The emotional parts of each picture were defined as areas of interest (AOIs). Fixations were identified using a

[7] Results are the same whether I used a 25% trackable or 50% trackable criterion, so I used the least exclusionary criterion.

fixation threshold of 100 ms. Subsequent analyses were conducted by looking at percent of fixation to the AOIs as a function of total fixation to the picture during the trial.

A 2 (age group) X 4 (regulation condition) univariate ANOVA was conducted using the percent fixation variable as the dependent variable (see Figure 13). There was no significant main effect of age. There was a significant main effect of condition $F(3, 174) = 12.505$, $p < .001$, partial eta squared = .177. Post hoc pairwise comparisons (Tukey's HSD) comparing all possible pairs revealed that people in the distraction condition fixated significantly less on the AOIs than people in every other condition ($p < .001$ in all cases). This is consistent with expectations. There was also a significant condition by age group interaction $F(3, 174) = 3.892$, $p < .05$, partial eta squared = .063.

The significant interaction effect was followed up with separate univariate ANOVAs within each age group. Within the young adult group, there was no significant effect of condition ($p = .106$), but within the older adult group there was a significant effect of condition $F(3, 67) = 13.14$, $p < .001$, partial eta squared = .370, with pairwise comparisons demonstrating that participants in the distraction condition fixated less to the AOIs than those in every other condition ($p < .005$).

Also of interest in these analyses was whether there would be an age difference in use of distraction. To that end, a planned 2 (age group) X 2 (condition: distraction versus control) univariate ANOVA was also conducted. The analysis revealed a main effect of condition $F(1, 86) = 19.503$, $p < .001$, with the distraction condition fixating less in the AOIs, as expected. It also revealed a condition X age group interaction effect $F(1, 86) = 6.921$, $p < .01$. Older adults in the distraction condition showed greater reductions in fixations to the negative AOIs relative to the control condition, when compared to young adults.

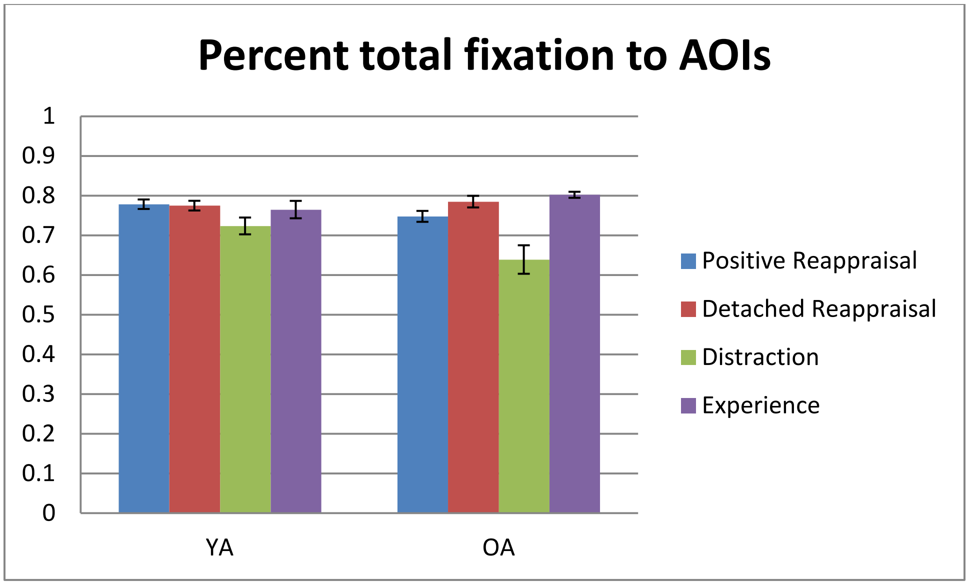

Figure 13. Percent total fixation to AOIs measured using the eyetracker. YA PR n = 26, DR n = 32, D n = 26, E n = 27; OA PR n = 16, DR n = 18, D n = 17, E n = 20.

The results were consistent with expectations, in that people who were asked to distract themselves from the negative pictures spent less time fixating on the negative content of the pictures, relative to total fixation on the pictures. This suggests that participants followed distraction instructions. Further, participants in all other conditions did attend to the negative pictures, as would be expected if they are following directions. The interaction effect, however, is also interesting. It appears that older adults were more likely to orient attention away from the negative aspects of the pictures, when asked to distract themselves. It should be noted that this does not mean that older adults were more capable of distraction in this paradigm. In this study, participants were not asked to distract themselves using gaze, but were instead asked to think about something other than the negative pictures. It is possible that young adults thought about something else while still viewing the pictures, but that older adults chose to use gaze to assist in distraction.

Summary of Manipulation Checks. The emotion induction worked. People generally appeared to use the appropriate regulation strategy, though many people used multiple strategies simultaneously, which will make results more messy. Further, although both age groups demonstrated use of distraction in gaze data, older adults appeared to use gaze to a greater extent to avoid the negative pictures.

Hypotheses Testing

Emotion regulation success.

For emotion regulation hypotheses, participants' reactions while regulating during the negative pictures (study 2) were compared to reactions during the negative pictures in study 1, where participants were asked to watch the pictures and experience their emotions. This strategy was used in both the self-reported emotion variables and the physiological variables.

Self-reported emotion. Hypotheses were tested by comparing emotion self-reports in the watch condition and the regulate condition using 2 (trial type: watch vs regulate) X 2 (age group) X 4 (regulation instruction) repeated measures ANOVA, with NA, PA, and valence self-reports as the dependent variables, trial type as a within subjects variable, and age as a between subjects variable. Self-reported emotion (NA, PA, or valence, as appropriate) at the end of the recovery period from study 1 was included as a covariate.

Negative affect. For NA, there was a significant main effect of trial type $F(1, 206) = 18.139$, $p < .001$, partial eta square = .081, with NA lower in the regulate epoch than the watch epoch. There was also a main effect of age $F(1, 206) = 12.209$, $p < .001$, partial eta square = .056 with older adults reporting higher negative affect overall, and a main effect of condition $F(3, 206) = 3.678$, $p < .05$, partial eta squared = .051. There was also a trial type X regulation instruction effect $F(3, 206) = 9.89$, $p < .001$, partial eta squared = .126. No other interactions were significant. Planned follow-up ANOVAs compared each regulation condition to the control (experience) condition in a 2 (age group) X 2 (regulation instruction) X 2 (trial type) repeated measures ANOVA, including the same covariate as the omnibus ANOVA. There were significant trial type X regulation instruction effects when comparing distraction to the experience condition $F(1, 101) = 10.489$, $p < .005$, partial eta squared = .094 and detached reappraisal to the experience condition $F(1, 105) = 23.109$, $p < .001$, partial eta squared = .294. In the distraction and detached reappraisal conditions, NA was significantly lower in the regulate epoch relative to the watch epoch [$F(1,50) = 16.733$, $p < .001$, partial eta squared = .251; $F(1, 54) = 16.792$, $p < .001$, partial eta squared = .237, respectively], but did not vary significantly in the positive reappraisal or experience conditions. See Figure 14. Lack of age differences in outcomes was inconsistent with expected age differences in patterns (outlined in hypothesis 1 and 2).

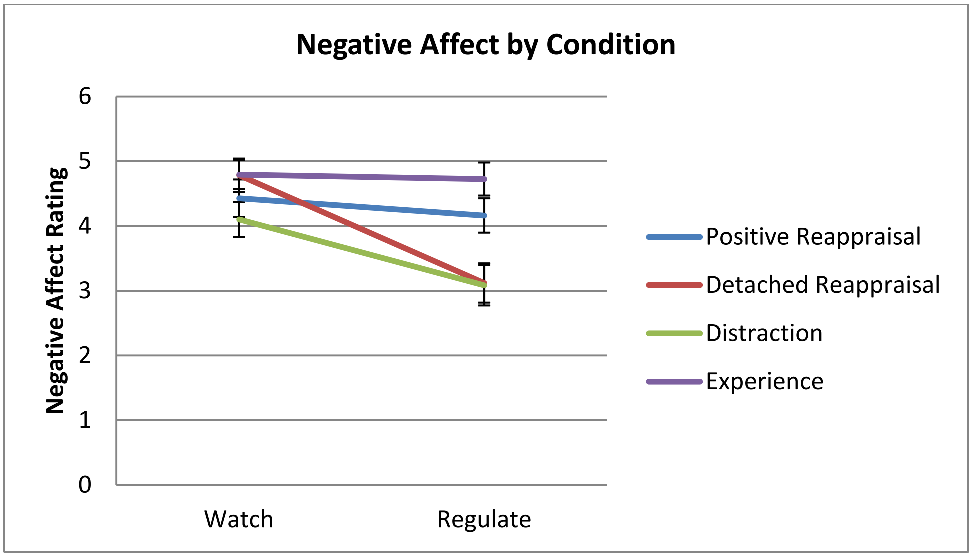

Figure 14. Self-reported negative affect by trial type and regulation condition. PR: n = 52, DR: n = 57, D: n = 53, E: n = 53.

Positive affect. For PA, there were no significant main effects or interaction effects (see Figure 15).

Valence rating. For the valence rating, there was a significant trial type X regulation instruction interaction effect F (3, 206) = 6.152, $p < .001$, partial eta squared = .084. This was qualified by a significant trial type X regulation X age group interaction $F(3, 206) = 4.765$, $p < .005$, partial eta square = .065. Separate follow-up 2 (trial type) X 4 (regulation instruction) repeated measures ANOVAs were then conducted within each age group. Within older adults, there were no significant main effects or trial type X regulation instruction effect. For young adults, however, there was a significant trial type X regulation instruction interaction F (3, 117) = 13.217, $p < .001$, partial eta squared = .253. See Figure 16.

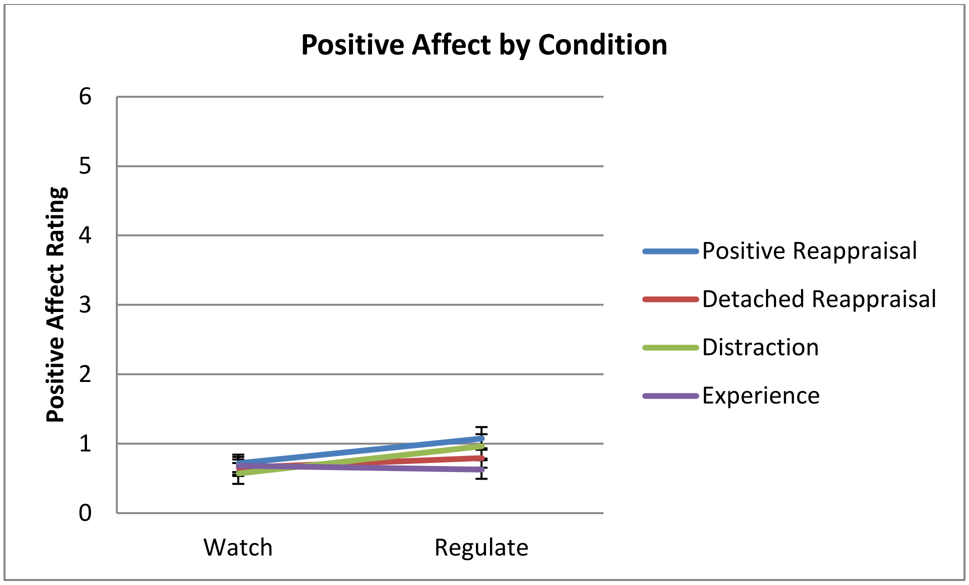

Figure 15. Self-reported positive affect by trial type and regulation condition. PR: n = 52, DR: n = 57, D: n = 53, E: n = 53.

To follow this up, separate repeated measures ANOVAs were conducted comparing each regulation condition to the experience condition for the young adult group. There was no significant interaction when comparing the distraction and experience conditions. However, there were significant interaction effects when comparing both detached reappraisal and positive reappraisal to the experience condition [$F(1, 60) = 35.734$, $p < .001$, partial eta squared = .373; $F(1, 57) = 18.696$, $p < .001$, partial eta squared = .247, respectively]. Whereas there was no difference between watch and regulate conditions for the positive reappraisal, distraction, and experience conditions, there was a significant increase in valence rating in the detached reappraisal condition $F(1, 31) = 8.089$, $p < .01$, partial eta squared = .207. These results support successful regulation by young adults in the positive and detached reappraisal condition, but not the distraction condition. In addition, older adults do not appear to successfully regulate, based on this emotion metric.

As an aside, it is interesting to note that older adults in the experience condition increase in valence more from the watch to regulate condition than do young adults in the experience condition, evidenced by a significant 2 (trial type) X 2 (age group) interaction effect conducted using just the experience condition participants $F(1, 50) = .750$, $p < .005$, partial eta squared = .103. This analysis was conducted post hoc after viewing the data. The fact that there is no 2 (trial type) x 4 (regulation instruction) interaction effect within the older adult group may be due to the fact that even the experience group appears to have improved in valence from the watch to regulate trial. Possible implications of this finding will be discussed in the discussion.

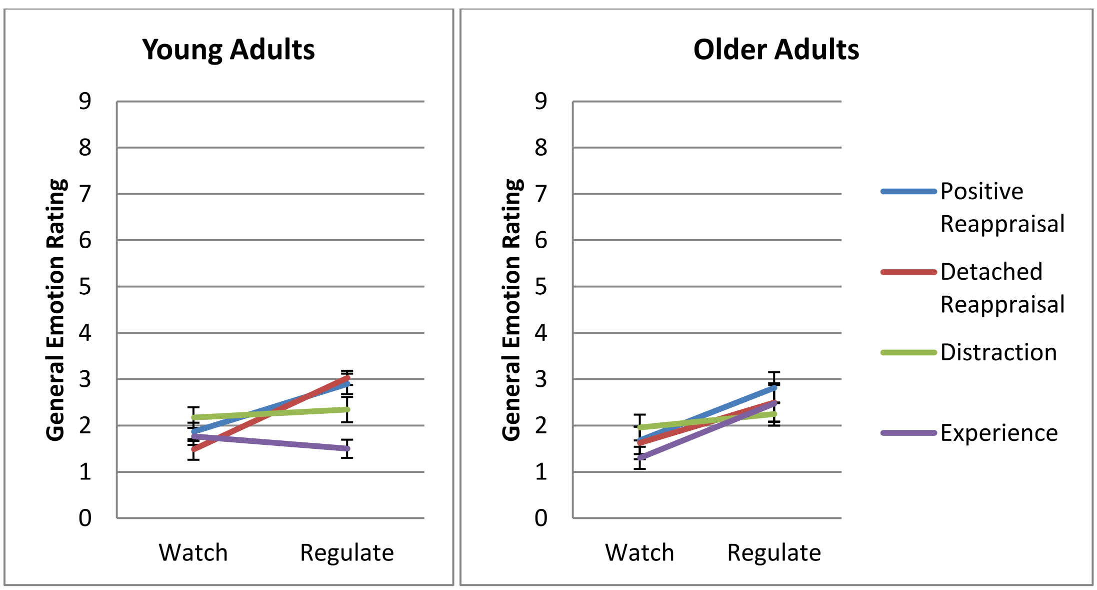

Figure 16. Self-reported valence for young and older adults by trial type for each condition. YA PR: n = 30, DR: n = 33, D: n = 29, E: n = 30; OA PR: n = 22, DR: n = 24, D: n = 24, E: n = 23.

Strength of emotion rating. The omnibus ANOVA revealed a significant trial type X regulation instruction interaction effect $F(3, 206) = 8.528$, partial eta squared = .110. This was followed-up using pairwise comparisons of each condition to the experience group. When comparing the distraction and experience condition, there was a significant main effect of condition F(1, 103) = 9.861, $p < .005$, partial eta squared = .087, which was qualified by a significant trial type X condition interaction F(1, 103) = 6.399, $p < .05$, partial eta squared = .058. Comparison between the detached reappraisal and experience conditions also evidenced a significant main effect of condition F(1, 107) = 6.665, $p < .05$, partial eta squared = .059, which was qualified by a significant trial type X condition interaction F(1, 107) = 16.332, $p < .001$, partial eta squared = .132. But comparison between the positive reappraisal and experience condition showed no significant effects, which is not surprising given that prior research has demonstrated that positive reappraisal causes shifts towards more positive emotion but does not appear to influence intensity of emotion (Shiota & Levenson, 2012). No group changed in emotion strength significantly from the watch to the regulate picture sets. However, participants in the experience and positive reappraisal conditions increased in emotion strength, whereas those in the detached reappraisal and distraction conditions decreased in emotion strength. It is possible that those in the detached reappraisal and distraction conditions showed decreased emotion strength because they were successfully regulating emotions, whereas those in the experience condition were not.

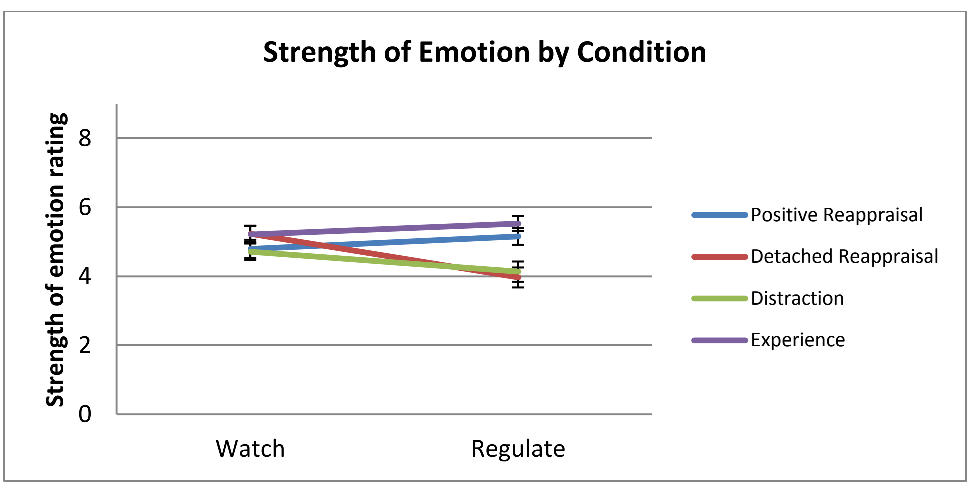

Figure 17. Self-reported strength of emotion by trial type for each condition. YA PR: n = 30, DR: n = 33, D: n = 29, E: n = 30; OA PR: n = 22, DR: n = 24, D: n = 24, E: n = 23.

Summary of self-report variables. The self-report variables, unexpectedly, provided very little evidence for age differences in regulation patterns between conditions (contrary to hypotheses 1 and 2). Instead, older and younger adults both seemed to successfully regulate in at least some metrics in the distraction and detached reappraisal conditions. Both groups were expected (hypotheses 1 and 2) to regulate successfully when using distraction, but older adults were not expected to successfully use detached reappraisal (hypothesis 1). Further, young adults evidenced down-regulation in the positive reappraisal condition in the valence metric whereas older adults did not, which was the opposite of expected findings laid out in hypotheses 1 and 2.

Physiology measures. For most physiology variables, 2 (time: trial versus baseline) X 2 (trial type: watch versus regulate) X 2 (age group) X 2 (sex) X 4 (regulation instruction) repeated measures ANOVAs were conducted, with sex and age group as between subjects factors, time and trial as within subjects factors, and the physiology variable of interest as the dependent variable. For certain variables, this type of analysis was not possible, and alternate analyses were used, as described when relevant. The goal of these analyses was to search for differences in arousal associated with different regulation instructions, to assess whether regulation was successful. As in study 1, only hypothesis-relevant effects will be discussed in the body of the paper. Other effects are included in Appendix G.

PEP. A significant time X trial type X age group X regulation instruction interaction effect emerged. To further understand this interaction, separate 2 (trial type) X 2 (time) X 4 (regulation instruction) ANOVAs were conducted for each age group.

Within young adults, no significant effects were found. Within older adults, there was a significant time X trial type X regulation instruction interaction effect F (3, 72) =

5.068, $p < .005$, partial eta squared = .174 (see Figure 18). To examine this interaction, separate 2 (trial type) X 2 (time) X 2 (regulation instruction) ANOVAs were conducted within the older adult group comparing each regulation instruction condition to the control condition (experience).

The comparison of the distraction condition with the experience condition did not reveal a time X trial type X condition effect, suggesting that OA participants in the distraction condition did not successfully regulate arousal (as measured by PEP). The comparison of the detached reappraisal and experience condition did reveal a significant time X trial type X regulation condition interaction effect $F(1, 40) = 3.909$, $p = .055$, partial eta squared = .089.The comparison of the positive reappraisal and experience conditions also revealed a significant time X trial type x regulation condition interaction effect $F(1, 37) = 5.142$, $p < .05$, partial eta squared = .122.

The two reappraisal groups were each compared to the experience group for the watch and regulate epochs separately. In comparing positive reappraisal to experience, there was a significant trial type X time interaction in both the watch epoch, $F(1, 40) = 4.819$, $p < .04$, partial eta squared = .108, and the regulate epoch $F(1, 37) = 4.032$, $p = .052$, partial eta squared = .098. Although neither group individually changed significantly in either the watch or regulate epoch, there was a cross-over interaction such that older adults in the positive reappraisal group increased in arousal during the watch epoch but decreased during the regulate epoch, whereas older adults in the experience epoch decreased during the watch epoch but did not change in arousal during the regulate epoch. These results suggest that older adults in the positive reappraisal condition were able to down-regulate arousal, supporting successful use of positive reappraisal.

Comparison of the detached reappraisal and experience group PEP scores suggested that there was no significant interaction during the regulate epoch, but there was a marginally significant interaction during the watch epoch $F(1, 40) = 3.663$, $p = .063$, partial eta squared = .084. Though, again, neither group evidences significant change during either epoch, there is a cross-over effect in the watch condition, such that those in the detached reappraisal condition do not change in arousal whereas those in the experience condition increase in PEP (decrease in arousal).

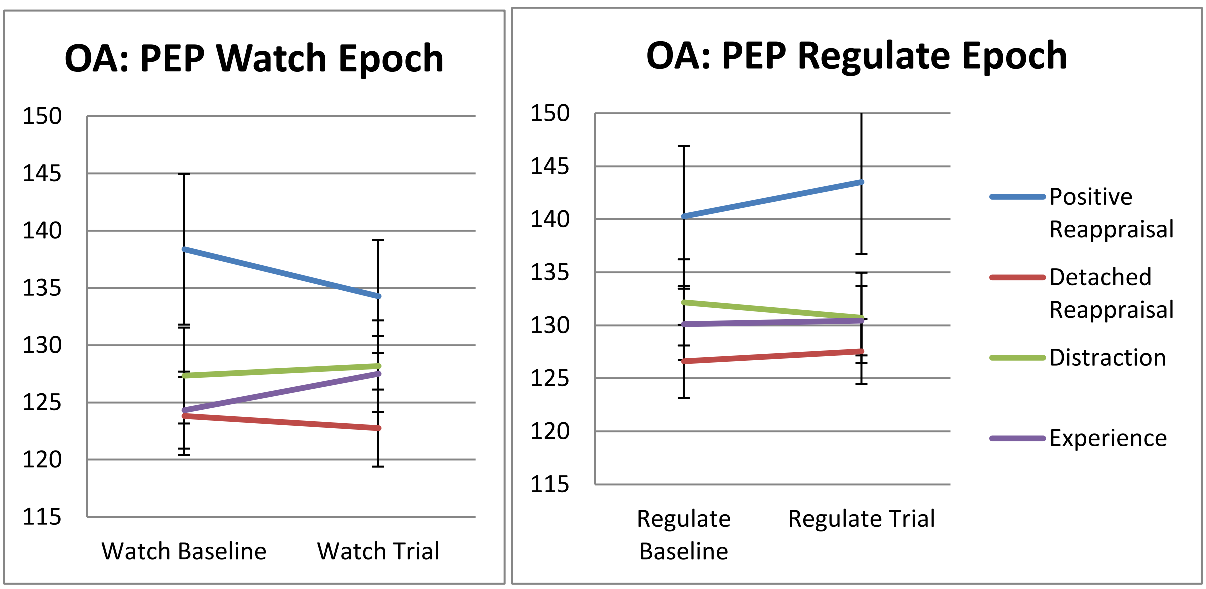

Figure 18. Pre-ejection period change from baseline to trial in watch and regulate epochs for older adults. PR n = 18, DR n = 21, D n = 20, E n = 21.

The PEP analyses suggest that OAs, but not YAs, demonstrate reduced arousal in the positive reappraisal condition relative to the experience condition. Though there is some evidence that older adults also may have down-regulated arousal in the detached reappraisal group, this may also be a product of differences in the watch epoch rather than differences in actual regulation success. Neither age group demonstrated decreases in PEP reactivity in the distraction condition.

To help interpret PEP results, correlations were calculated between PEP and self-reported emotion variables, but no significant correlations emerged.

IBI. A main effect of time emerged $F(1, 174) = 15.092$, $p < .001$, partial eta squared = .08, such that IBI was higher during the trial periods than the baseline periods, as is consistent with an orienting response. Although the main effect of time demonstrates an orienting effect that suggests participants attended to the negative pictures, there were no interactions involving time X trial type and therefore no evidence for lower arousal in response to regulation instructions.

TPR. There were no significant effects involving the interaction of time and trial type, so there was nothing in the TPR data to suggest that participants responded physiologically differently to watching negative pictures versus regulating emotions during negative pictures.

MAP. No significant time X trial type effects were found.

EDA. TSCL and SCR were included as dependent variables in separate analyses. In TSCL analyses, there was a marginally significant time X trial type interaction effect $F(1, 184) = 3.672$, $p = .057$, partial eta squared = .02. Follow-up repeated measures ANOVAs conducted separately for the watch and regulate epochs suggested that participants increase in TSCL slightly (but not significantly) from baseline to trial in the watch epoch, but decrease in TSCL slightly (but not significantly) in the regulate epoch, which would be consistent with participants in the regulate epoch experiencing less picture-related arousal, possibly due to habituating to the picture presentation procedures. However, there was no evidence for any regulation instruction resulting in lower TSCL response.

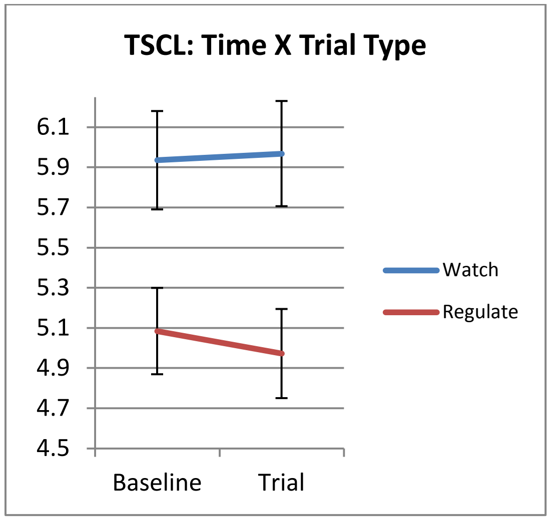

Figure 19. Change in total skin conductance level comparing watch and regulate epochs.

A 2 (trial type: watch versus regulate) X 2 (age group) X 2 (sex) X 4 (regulation instruction) repeated measures ANOVA was conducted using SCR count as the dependent variable. Analyses revealed a significant main effect of trial type $F(1, 184) = 14.162$, $p < .001$, partial eta squared = .071, with participants demonstrating fewer SCRs in the regulate condition relative to the watch condition (see Figure 20). This could be the result of habituation to the picture presentation paradigm, which seems most likely given that there is no trial type X regulation instruction interaction effect, which would suggest that the decrease depended on whether participants tried to regulate emotions.

RSA. RSA was not calculated for the watch epoch because it was expected to respond to effort rather than emotion. Analyses for this epoch included RSA as a dependent variable in a 2 (time) X 2 (sex) X 2 (age group) X 4 (regulation instructions). There was a significant time X regulation instruction interaction $F(3, 169) = 4.294$, $p < .01$, partial eta squared = .071. To examine the interaction, separate 2 (time) X 2

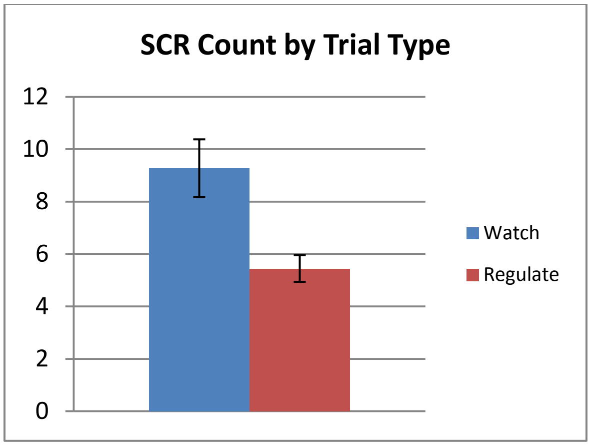

Figure 20. Skin conductance response count by epoch.

regulation interaction when comparing participants in the distraction and experience conditions or the detached reappraisal and experience conditions. However, there was a significant time x regulation instruction interaction $F(1, 86) = 8.66$, $p < .005$, partial eta squared = .091 when comparing the positive reappraisal and experience conditions (see Figure 21). There were significant increases in RSA in the experience condition $F(1, 46) = 4.801$, $p < .05$, partial eta squared = .095, but there were significant decreases in RSA from baseline to trial in the positive reappraisal condition $F(1, 40) = 4$, $p = .052$, partial eta squared = .091[8], which may indicate decreased effort in the positive reappraisal condition relative to the experience condition or may reflect increased positive affect in the positive reappraisal condition and decreased positive affect in the experience condition. This finding will be discussed in more detail in the discussion. Due to the ambiguous meaning of RSA, I also examined correlations between RSA and self-reported emotion. RSA did not correlate with self-reported emotion, except in the detached reappraisal condition, where decreases in RSA were associated with

[8] Analysis on RSA was also conducted using residuals created from regressing trial performance on baseline performance as the dependent variable and including RRAT as a covariate. The effect of regulation instruction became marginally significant in this version of analysis.

increases in positive affect. There were no other meaningful variables in this study to correlate with RSA to help determine its meaning in the current context.

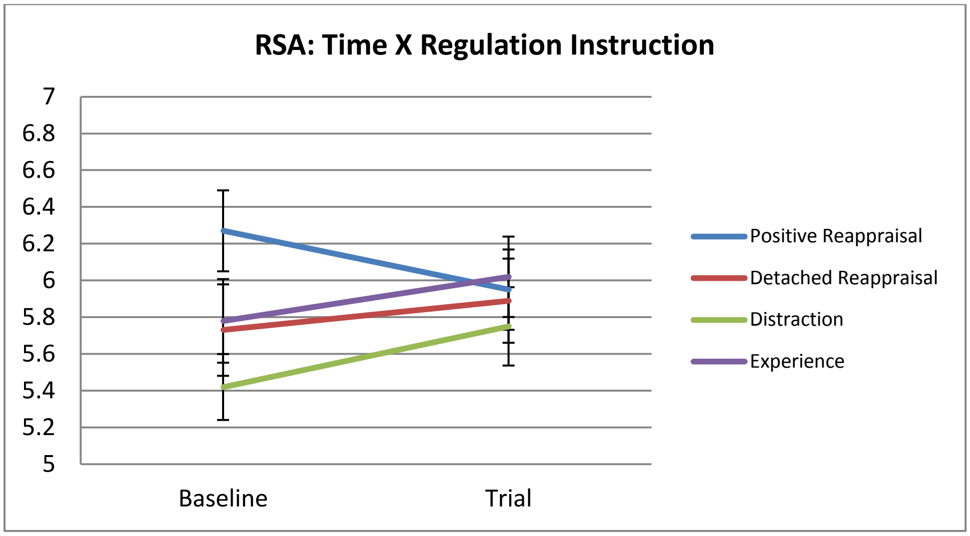

Figure 21. Change in RSA in each regulation condition. PR n = 41, DR n = 50, D n = 47, E n = 47.

Depletion costs hypotheses

Reaction time. The N-back reaction time data was analyzed using a 2 (age group) X 4 (condition) X 2 (time: baseline versus after the induction) repeated measures ANOVA, with age group and condition as between subjects variables and time as the within subjects variable (see Figure 22). A significant main effect of time emerged F (1, 198) = 8.450, $p < .005$, partial eta squared = .041, with participants displaying slower RTs at time 2. A significant time X age group effect also emerged F (1, 198) = 7.218, $p < .01$, partial eta squared = .035, with older adults increasing more in RT from baseline to induction. The main effect of age was also significant $F(1, 198) = 11.065$, $p < .001$, partial eta squared = .053, with older adults having longer RTs. No other significant effects emerged. Because I had specific hypotheses within each age group, I also conducted ANOVAs within each age group, but they did not suggest any different pattern than that suggested by the omnibus ANOVA. The results in the N-back reaction time variable preclude assessment of hypotheses 3 and 4 using this variable.

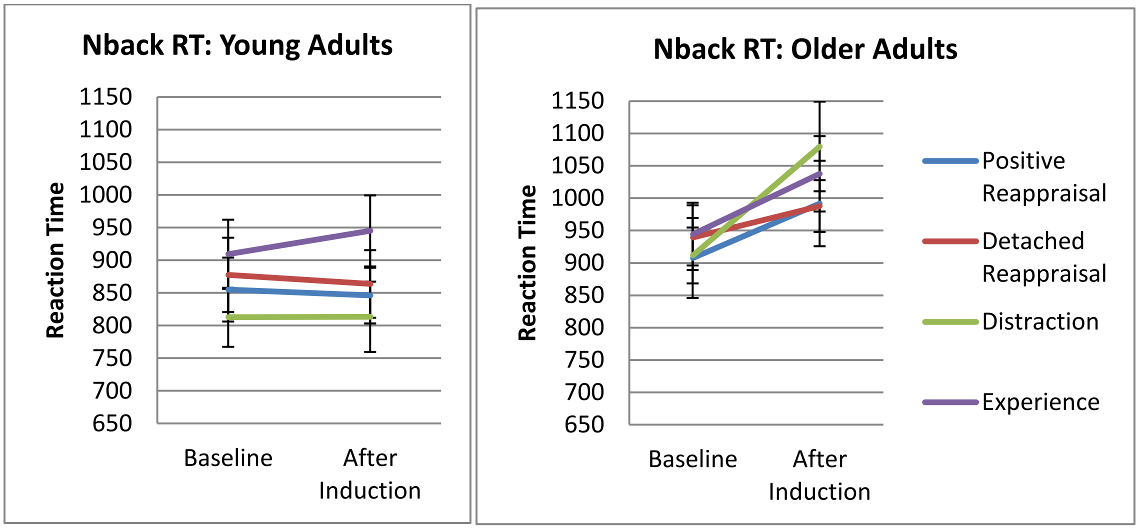

Figure 22. Reaction time in the N-back task before and after induction for young and older adults separately. YA PR n = 28, DR n = 31, D n = 28, E n = 29; OA PR n = 21, DR n = 23, D n = 24, E n = 22.

Accuracy. First, I confirmed that there were no significant differences in accuracy during the baseline. This should be true, given that I selected which N-back version each participant would do at time 2 based on accuracy on each version at time 1. However, there was some variability in exactly how accurate people were, so checking for statistical differences was important. A 2 (age group) X 4 (condition) ANOVA did not reveal any significant main effects or interaction effects. On average, participants were 83% accurate on the N-back version selected for them during the baseline, which is close to our target 80% accuracy rate. I also checked to see if there were differences between conditions in N-back version used in session 2. There was a significant main effect of age group F (1, 198) = 92.064, $p < .001$, partial eta squared = .317. Older adults typically completed a 2 or 3 back, whereas younger adults typically completed a 3 or 4 back. There were no effects of condition or an age group X condition effect, suggesting random assignment was effective.

Accuracy for N-back following the induction was examined in a 2 (age group) X 4 (condition) ANOVA. There was a significant main effect of condition $F(3, 199) = 3.119$, $p < .05$, partial eta squared = .045, but no age-related interaction effects were significant (see Figure 23). Follow-up comparisons reveal that participants in the positive reappraisal and distraction conditions were significantly more accurate than participants in the experience condition ($p < .05$), which is inconsistent with our hypotheses (3 and 4). Average accuracy following the induction was 81%.

Planned ANOVAs were conducted for each age group. For young adults, there was a significant effect of condition $F(3, 113) = 4.644$, $p < .005$, partial eta squared = .110. Pairwise comparisons demonstrate a significant difference in accuracy performance of participants in the positive reappraisal condition ($p < .01$) and the distraction condition ($p < .05$) compared to the experience condition, with the experience condition being less accurate. Within the older adult sample, there was no significant effect of condition, but examination of the means suggests the pattern is similar to that found in YAs, as suggested by the lack of age X condition interaction effect. In addition, because the older adult group had fewer participants, it seems likely that patterns may have been similar and significant with a greater sample size. Accuracy results do not support hypotheses 3 and 4. In fact, the lower accuracy of the experience group is in direct opposition to what would be expected due to depletion. People experiencing the emotion should use the least amount of self-control resources and therefore be the least impacted on the N-back. Alternative explanations will be explored in the discussion.

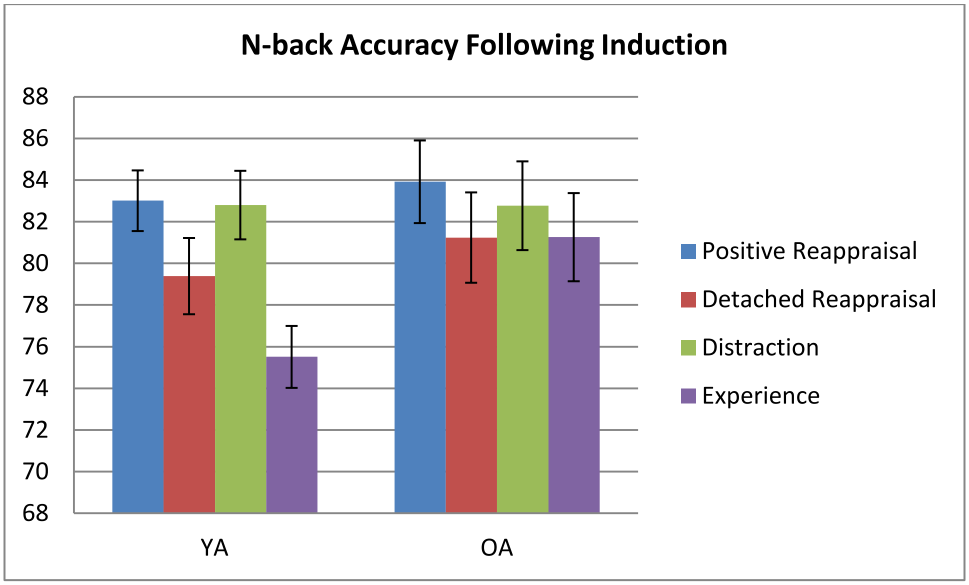

Figure 23. N-back accuracy by condition and age group following the emotion induction. YA PR n = 28, DR n = 31, D n = 28, E n = 29; OA PR n = 21, DR n = 23, D n = 24, E n = 22.

Arousal and emotion variables as covariates. One possibility in explaining accuracy effects could be changes in arousal or motivation that then drive performance in the subsequent N-back task. To investigate this possibility, I examined the impact of including physiological and self-reported emotion covariates in the above described models. For the arousal variables, each physiological variable during the picture trial was regressed on the same physiological variable at baseline and the residuals were saved. The residuals were used as quantifications of arousal. For self-reported emotion, NA, PA and valence reported during the picture presentation was used. The first ANOVA included all of the physiological variables as covariates. Inclusion of these variables eliminated the significant main effect of regulation condition. This provides some evidence that differences in the N-back task seem to be specifically related to physiological arousal during the negative pictures.

The second ANOVA included all of the self-reported emotion variables as covariates. This model still evidenced a significant main effect of regulation condition $F(2, 195) = 3.319$, $p < .05$, partial eta squared = .049, suggesting that levels of self-reported emotion during the regulation task cannot explain subsequent condition differences in the N-back task.

I also looked to see whether accuracy performance correlated with self-reported emotion or physiological variables (individually), but there were no significant correlations within any condition. This may undermine the idea that emotion or arousal underlie differences in performance in the N-back task, though there are also small cell sizes for the correlations. No other interesting covariates were available that addressed other potential reasons for differences in performance between condition (such as motivational differences between conditions).

Memory costs hypotheses.

Recognition memory variable. Items from the recognition test were coded as central or peripheral detail. Central detail is detail that is considered thematically central to the picture and peripheral detail is considered something that is in the picture but does not impact the meaning of the picture. In the case of this study, this meant that central details related to the emotional content of the picture and peripheral details related to other parts of the picture. This coding scheme was taken from Payne et al (2006). For more description of reasons why these variables were chosen and information about the recall variable, see Appendix H.

The memory hypotheses were tested using separate 2 (age group) by 4 (condition) ANOVAS with age and condition as between subjects variables and each recognition memory variable as the dependent variable (Free recall: gist, detail, false detail; recognition: peripheral detail, central detail). For the recall variables, separate 2 (age group) X 4 (condition) X 2 (trial type: watch vs regulate) repeated measures ANOVA were conducted using each recall variable as the dependent variable. The length of the delay between the session and the follow-up call, where memory was assessed, was used as a covariate.

Recognition memory, central detail. Analysis conducted using the central detail score from the multiple choice follow-up interview demonstrated a significant main effect of regulation condition $F(3, 189) = 3.243$, $p < .05$, partial eta squared = .049, but this became only marginal when the delay covariate was included $F(3, 181) = 2.160$, $p = .094$, partial eta squared = .035. No other effects were significant. Follow-up pairwise comparisons demonstrated a marginally significant main effect of condition when comparing the positive reappraisal and experience conditions $F(1, 88) = 3.716$, $p = .057$, partial eta squared = .041, consistent with the expectation that elaboration associated with reappraisal might boost memory (hypothesis 6). Recognition memory for central detail did not differ significantly between the detached reappraisal or distraction condition and the experience condition, inconsistent with hypothesis 6 expectation that detached reappraisal might boost memory and that distraction might harm memory. See Figure 24.

Despite a lack of condition X age interaction, I conducted separate ANOVAs comparing conditions within each age group, consistent with planned analyses. For young adults, a significant main effect of condition emerged $F(3, 105) = 3.419$, $p < .05$, partial eta squared = .089. Follow-up pairwise comparisons demonstrate a marginally significant difference when comparing the positive reappraisal condition to the experience condition ($p = .063$) and a significant difference when comparing distraction and experience conditions (p < .05). For older adults, there was no significant main effect of condition.

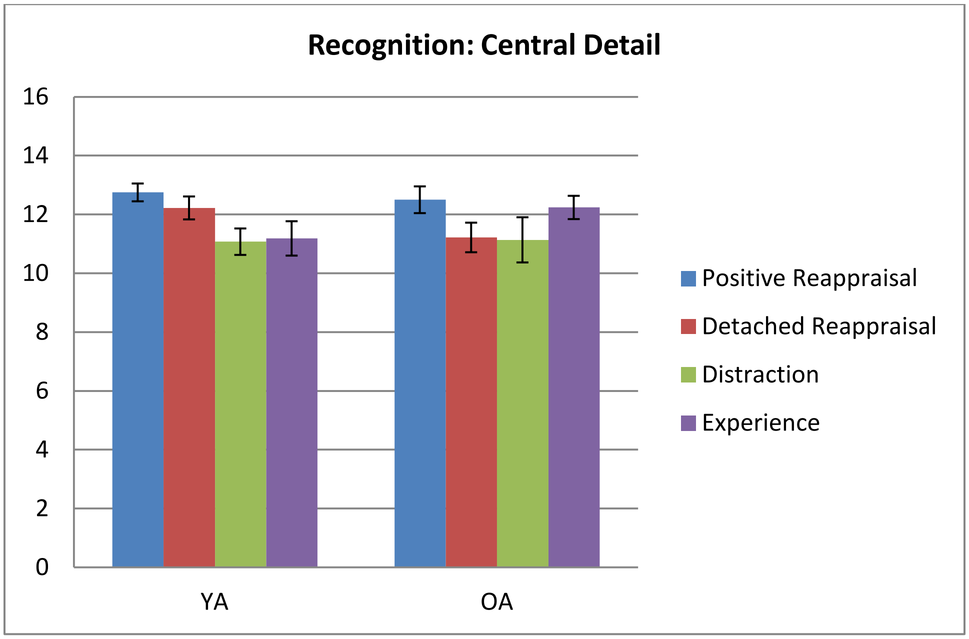

Figure 24. Scores on the central detail recognition variable. YA PR n = 28, DR n = 27, D n = 27, E n = 27; OA PR n = 22, DR n = 23, D n = 22, E n = 21.

Recognition memory, peripheral detail. Analysis using the peripheral multiple choice questions also demonstrated a main effect of regulation condition $F(3, 181) = 3.41$, $p < .05$, partial eta squared = .053. There was also a main effect of age group $F(1, 181) = 3.968$, $p < .048$, partial eta squared = .021, such that older adults were slightly more accurate (YA mean: 6.075, OA mean: 6.727). Follow-up pairwise 2 (age group) X 2 (regulation condition) comparing each regulation condition to the experience group were conducted. The comparison of the distraction and control conditions revealed a marginally significant effect of condition $F(1, 87) = 2.955$, $p = .089$, partial eta squared = .033, such that participants in the distraction condition remembered marginally more peripheral details than those in the experience condition, possibly reflecting an attempt to keep attention away from the emotionally central details. This was in contrast to hypothesis 5 expectations, but makes conceptual sense, which will be discussed later. There was a significant effect of condition when comparing detached reappraisal and control participants' performance $F(1, 90) = 7.416$, $p < .01$, partial eta squared = .076, and positive reappraisal to the control group's performance $F(1, 88) = 10.157$, $p < .005$, partial eta squared = .103, such that participants in the reappraisal conditions recognized greater peripheral detail than those in the experience condition, as posited in hypothesis 6. Reappraising the pictures appeared to help people remember details of the pictures that were not central to the emotional content of the pictures, possibly because they used these details in their elaboration process. This does appear to confirm that participants in the reappraisal conditions (and to a lesser extent the distraction condition) did pay attention to the pictures in a different way than participants who were just allowing their emotions to happen. See Figure 25.

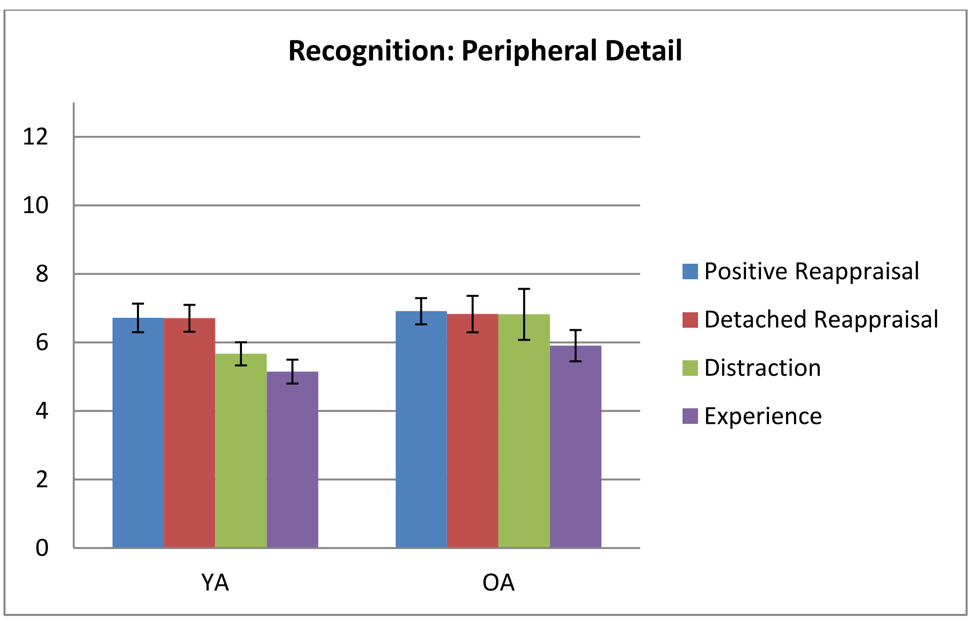

Figure 25. Scores on the peripheral detail recognition variable. YA PR n = 28, DR n = 27, D n = 27, E n = 27; OA PR n = 22, DR n = 23, D n = 22, E n = 21.

In no pairwise comparison did an age X regulation condition interaction emerge, suggesting that older and younger adults' recognition memory for peripheral details did not follow significantly different patterns, which seems consistent with visual inspection of the data.

Recall memory, gist. Analysis conducted using the recall gist variable revealed a main effect of age group, $F(1, 164) = 4.311$, $p < .05$, partial eta squared = .026, such that young adults free recalled the gist of more pictures overall. There was also a main effect of trial type $F(1, 164) = 4.212$, $p < .05$, partial eta squared = .025. This was qualified by a trial type by regulation condition interaction $F(3, 164) = 10.313$, $p < .001$, partial eta squared = .092. Each regulation condition was compared to the experience condition using a 2 (age group) X 2 (condition) X 2 (trial type) repeated measures ANOVA. In comparing the distraction and experience condition, there was a trial type by condition effect $F(1, 84) = 9.165$, $p < .005$, partial eta squared = .098. Comparison of the detached reappraisal and experience conditions also revealed a significant trial type by condition effect $F(1, 83) = 12.827$, $p < .005$, partial eta squared = .134. There was no significant interaction effect when comparing the positive reappraisal and experience conditions. Repeated measures ANOVAs comparing gist recall of pictures in the watch and regulate epochs within each regulation condition suggests that there was no difference in watch and regulate gist recall in the experience or positive reappraisal conditions, but there was a significant effect of trial type for the detached reappraisal $F(1, 42) = 10.983$, $p < .005$, partial eta squared = .207, and the distraction conditions $F(1, 43) = 6.620$, $p < .04$, partial eta squared = .133, such that participants in these two conditions remembered fewer regulate than watch items. This supports the hypothesis 5 expectation that distraction would impair memory for the negative pictures. It also demonstrates that detached reappraisal was associated with gist deficits, which may be associated with reduced emotion and arousal in that condition, which was set up as a possibility in hypothesis 6.

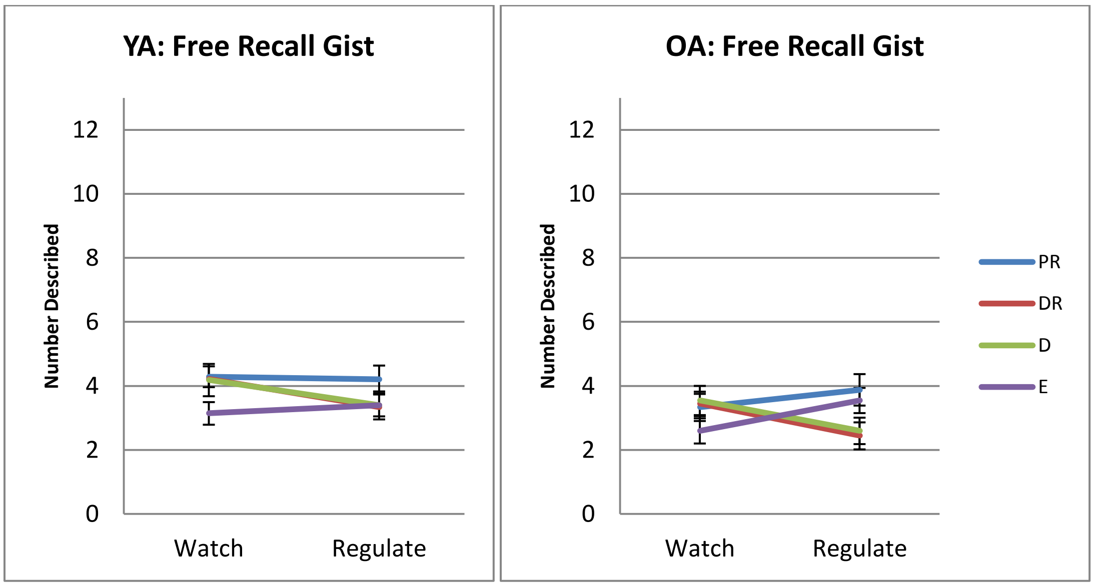

Figure 26. Counts for recalled gist by age group. YA PR n = 24, DR n = 25, D n = 24, E n = 24; OA PR n = 17, DR n = 18, D n = 20, E n = 20.

Recall memory, detail. Analysis using the recall detail variable as a dependent variable demonstrated a significant main effect of age group $F(1, 162) = 6.083$, $p < .05$, partial eta squared = .036, such that older adults described more details for the pictures they recalled. There was also a trial type X age group interaction $F(1, 162) = 6.037$, $p < .05$, partial eta squared = .036 (see Figure 27). Follow-up ANOVAs compared each age group during the watch and regulate epochs separately. There was no significant age difference in detail recall in the watch epoch, but older adults recalled significantly more details in the regulate epoch $F(1, 168) = 9.882$, $p < .005$, partial eta squared = .056. The increase in OA detail description did not vary based on condition, so it does not seem to be a product of regulation strategies. The outcome of this variable did not seem to conform to the hypotheses (5 and 6) or refute them.

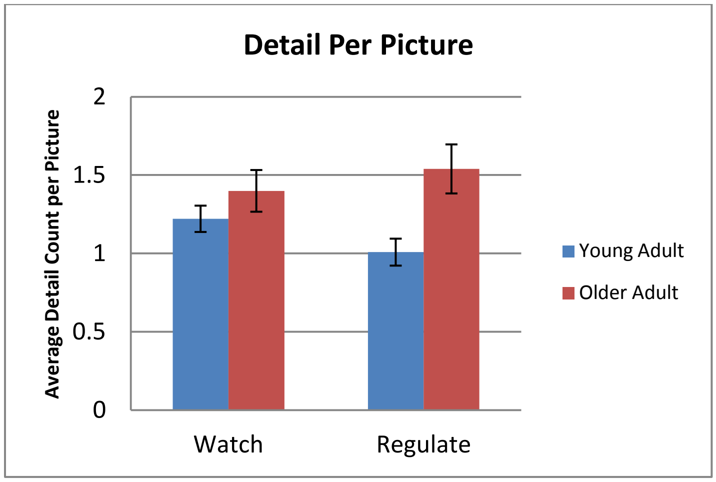

Figure 27. Average number of details per picture described by each age group in the watch and regulate epochs. YA n = 97, OA n = 76.

Recall memory, false detail. There was a significant main effect of age F(1, 164) = 9.764, p < .005, partial eta squared = .056, such that older adults were more likely to recall false details than young adults. No other effects were significant.

Discussion

The study sought to extend prior research by replicating age differences in success using two commonly used reappraisal strategies and extend this research by examining age differences in success using another highly successful regulation strategy, distraction. Further, I sought to examine the cost profiles of each strategy by measuring cognitive resources necessary for each strategy and memory costs associated with use of each strategy. It was expected that profiles might differ somewhat between age groups, though this hypothesis was not confirmed.

Emotion Regulation Success

The study found almost no evidence for changes in emotion regulation success based on age in any of the conditions. In contrast to hypotheses 1 and 2, both age groups demonstrated ability to down-regulate emotions in all three conditions, although the ability manifested in different variables in each condition.

Distraction resulted in the expected decreases in negative affect and emotional intensity ratings (i.e. successful regulation), but there were no age differences in these patterns. Failure to find age-related improvement in online use of distraction contrasts with the findings of Phillips et al (2008), where older adults demonstrated lower negative affect when distracting themselves during a negative film clip, but young adults showed no improvement associated with distraction. However, that study was unusual in that young adults do typically show emotional improvements when distracting themselves in other studies (Sheppes & Meiran, 2007; Thiruchselvam et al, 2011). Also, Phillips and colleagues used a particular type of distraction called positive refocusing in which participants practiced thinking about a specific positive personal experience and later used this positive experience to distract themselves during the film clips. Providing participants with specific, salient, emotional distractor thoughts might benefit older adults more than young adults. This might eliminate effortful or difficult processes such as self-selecting an alternative set of thoughts, and it might benefit older adults in that positive emotional thoughts might be attention capturing which might help counter attention deficits. Positive refocusing might also cater to older adults' natural tendency to favor positive information over negative information, as found in some positivity effect research. Therefore, improved use of online distraction in older adults (when both age groups are trying to distract) may not be the norm, but instead an outcome of using a very specific type of distraction strategy.

Positive and detached reappraisal were also associated with changes in emotion, but in different ways. Detached reappraisal was associated with decreases in negative affect and strength of emotion (emotional intensity) when asked to regulate compared when just watching negative pictures. For young adults (though not for older adults) detached reappraisal was also associated with increases in valence, which is also consistent with emotion regulation. Positive reappraisal was also associated with some evidence of successful down-regulation, though the specific manifestation varied between the two age groups. Young adults in the positive reappraisal condition demonstrated increases in valence[9], consistent with increases in positive emotions. Older adults in the positive reappraisal condition experienced increases in arousal in PEP when just watching negative pictures but decreases in arousal in PEP when using positive reappraisal, which was significantly different from the trend found in the experience group. This pattern is consistent with successful reduction of arousal in the positive reappraisal condition for older adults. Although evidence for successful positive reappraisal is different in the two age groups, both do appear to manifest positive reappraisal. There was also RSA evidence in both age groups, to be discussed momentarily, that may also be associated with regulation in the positive reappraisal condition, though interpretation of that data is less straight forward.

As in Shiota and Levenson's (2012) findings, my results appear to confirm that detached reappraisal decreases both the intensity of emotion felt and the degree of

[9] Lack of regulation-related valence changes in older adults (in the detached and positive reappraisal conditions) may be due to the fact that the older adults increased slightly (but not significantly) in valence in all conditions, including the experience condition. On the other hand, young adults decreased slightly, but not significantly, in valence in the experience condition. This increase in valence in older adults may have undermined ability to see differences between conditions. However, examination of the patterns in regulation conditions suggests that older adults behaved similarly to young adults, providing a little bit of evidence that they may have regulated in the positive and detached reappraisal conditions in the same way that young adults did even in this variable.

negative emotion experienced, whereas positive emotion appears to primarily increase positive emotion but leave intensity of emotion unaltered. I did not replicate their physiological findings as closely, however. They found evidence for decreased arousal associated with detached reappraisal, but I did not. As mentioned previously, physiological indicators are influenced by a variety of factors and differences in emotional stimuli may have allowed physiological patterns to emerge in their data but not in ours. Further, they found evidence that positive reappraisal reduced arousal for men but increased cardiovascular arousal for women (in a pattern similar to a challenge-response), but the current study found that positive reappraisal appeared to decrease arousal (as measured by PEP) but this was not related to sex.

Though the exact patterns varied a little for older and younger adults, it appeared that both age groups regulated to some extent in all conditions in the current study. The lack of age differences in the reappraisal strategies is in contrast to the findings of Shiota and Levenson (2009), who demonstrated an age-related increase in ability to enact positive reappraisal and an age-related decrease in ability to enact detached reappraisal. One possible reason for the disparate findings could be the nature of our stimuli. Their study used sad and disgusting film clips. Although I endeavored to choose stimuli that would provide a strong regulatory load, it is possible that our task was inadvertently less evocative than theirs. It is also possible that their film clips drew on age-related biases more than ours did. For example, the disgust-eliciting clips used by Shiota and Levenson was taken from the popular reality show *Fear Factor*, which may have been more familiar to young adults, making them more practiced in ability to detach from it. The sad film clips both included scenes of death involving close interpersonal relationships. Older adults' life experiences may make these clips easier to positively reappraise, but the increased value that they place on close interpersonal relationships may make it more difficult for them to disengage from these types of scenes. More direct comparisons of stimuli types (clips versus pictures versus other inductions) and stimuli content is needed to clarify what factors may influence age-related differences in reappraisal abilities.

There were two findings within the physiology variables that are somewhat ambiguous. As alluded to earlier, the RSA decrease in the positive reappraisal group is somewhat complicated to interpret. There are studies that demonstrate RSA decreases in association with increases in positive affect (Shiota et al, 2011). However, in some studies decreases in RSA are associated with both negative and positive arousal (Frazier, Strauss, & Steinhauer, 2004), and in other studies, positive affect has been associated with increases in RSA (McCraty et al, 1995). When assessing RSA and the emotion self-reports together in our study, it seems most likely that RSA in our study is indexing changes in positive emotion. In our study, decreased RSA occurred in the same condition where YAs evidenced increases in valence ratings, which also likely reflects increased positive affect, Increased RSA in the experience condition was coupled with lower levels of valence. Therefore, it is possible that the decreased RSA in the positive reappraisal group in our study reflects increased positive affect (and therefore successful positive reappraisal). This is also consistent with the significant correlation of RSA and positive affect in the detached reappraisal condition, though similar correlations did not emerge in other conditions.

However, another interpretation of RSA is also possible. Studies find that RSA increases are also associated with increased self-regulatory effort. For example, Butler et al (2006) find that RSA increases are found in participants who are trying to either reappraise or suppress affect while having an emotional conversation. Only those in the reappraise condition demonstrate successful emotion regulation, but both groups demonstrate increased RSA. Other research has also demonstrated increased RSA associated with other types of self-regulatory efforts such as completion of working memory tasks (Hansen, Johnsen, & Thayer, 2003). Therefore, it is possible that decreased RSA in the positive reappraisal condition reflects decreases in self-regulatory effort, and increases in the experience condition reflect increases in self-regulatory effort. However, this does not seem to make theoretical sense. It seems unlikely that positive reappraisal would result in decreased self-regulation relative to relaxing during the baseline. Therefore, the emotional explanation of the RSA findings seems most likely.

The difference in PEP between the experience and detached reappraisal condition in the older adult group is also somewhat ambiguous, but most likely to reflect a difference in attention between the two conditions, rather than a regulation difference. I found that there was no significant difference in change in PEP during the regulate trial, but during the watch trial, the experience group increased in PEP significantly, whereas there was no change in the detached reappraisal group. PEP can be sensitive to changes in arousal caused by emotion (shorter PEP would indicate greater emotion) and attention (shorter PEP would mean less attention), though its relationship to attention is not completely clear. When PEP changes, one or both of these factors could be the cause. In both conditions, during the watch epoch, both groups were experiencing negative emotions. During the watch condition, the increases in PEP in the watch condition are most likely related to orienting responses and not to reductions in emotional arousal, which would be inconsistent with self-reported affect. In the regulate epoch, participants in the experience condition did not demonstrate significant changes in any self-reported emotion variable, so their emotional response was the same in both conditions, but their PEP response was lessened. Because arousal due to emotion should be similar, this likely means that older adults in the experience condition were disengaging attention somewhat. In contrast, older adults in the detached reappraisal group did demonstrate decreases in reported emotion, but did not decrease in arousal, suggesting that they were maintaining or increasing in levels of attention even though those in the experience group appeared to be decreasing in levels of attention. It is possible that this type of pattern might be caused by habituation in the experience group (who were, in essence, doing the same thing they did in study 1 a second time) whereas the participants in the detached reappraisal group were not habituating because they were doing a somewhat new task. It is also possible that the participants in the detached reappraisal group were deploying more effortful resources. The current study cannot differentiate between the two possibilities. Given the unexpected nature of this finding and the unusual nature of the interaction (significant differences in the watch condition that disappear in the regulate condition), replication of this finding is necessary before any conclusions are drawn.

Resource Demands of Regulation Conditions

Contrary to expectations of hypotheses 3 and 4, there were no age differences in patterns of depletion costs between conditions, and depletion costs did not emerge in expected conditions. In fact, the results seem to suggest that the depletion paradigm itself may be measuring something other than use of self-control resources. Participants in the experience condition suffered reduced N-back accuracy compared to all of the regulation conditions, which is completely inconsistent with the conceptualization of depletion espoused by Baumeister, in which only self-regulatory attempts should cause depletion (and allowing yourself to naturally experience emotion should not require self-regulation).

Other researchers have also suggested that the depletion effect is not related to use of self-control resources. For example, depletion effects may be caused by changes in motivation (for a review and meta-analysis of this hypothesis and other alternative explanations, see Haggar et al, 2010). Doing tedious self-control tasks may demotivate participants and cause them to put less effort into subsequent tasks. In the experience group in our study, participants were asked to do an unpleasant task for the second time and may become less motivated to continue. In the other conditions, participants were still viewing negative images, but their experience was less unpleasant (because they regulated) and less repetitive (because they have regulation instructions to follow). Bolstering this interpretation is the fact that in the SOC writings in study 1, I saw some evidence that participants became less motivated to continue the experiment after the negative pictures (saying things like, “now I don’t care so much about finishing the study”—though it should be noted that no one asked to withdraw). Another possibility is that changes in arousal or mood might impact performance in depletion paradigms. In the current study, adding the physiological variables as a covariate eliminated the effect of regulation instruction on N-back performance, suggesting that arousal levels may account for decreased performance in the experience condition relative to the positive reappraisal and distraction conditions. The experience group, who may have been somewhat more aroused since they did not regulate emotions (even though I found minimal evidence for this in individual arousal measures), may have been impaired by their increased arousal. An arousal-related explanation is supported in prior research on the depletion effect that suggests that mood inductions that improve mood and arousal actually eliminate the depletion effect (Haggar et al, 2010).

There are other possible explanations as well. Prior experience regulating might influence the degree to which participants continue to have intrusive thoughts about the pictures while they are doing the N-back task. For example, people who regulate successfully may experience reduced tendency to ruminate and this may help them to concentrate more on the N-back task. This explanation would be consistent with the findings in study 1, which suggested that ruminative thoughts were greater in participants who experienced a greater emotion induction. The current study did not include any indicators of ruminative thoughts, so this hypothesis cannot be examined in the current data.

Other researchers suggest that emotion regulation actually recruits cognitive control that may influence other tasks. Wilkowski and Robinson (2008) demonstrated that people who were low in trait anger demonstrated reduced switching costs in a flanker task when they were in a hostile context. They suggested that these participants, in order to deal with the hostile context, draw on cognitive control to manage potential anger and that this recruited cognitive control assists with the performance of the task. Their time frame is much shorter than ours. But, it is possible that participants in the positive reappraisal and distraction conditions recruited cognitive control resources to regulate emotions and benefited from this cognitive engagement during the subsequent N-back task.

Drawing firm conclusions about which mechanism accounts for the results is not possible in the current study, although the arousal mechanism does have some support based on the data available. The alternative explanations should be examined in future research using more variables that address each hypothesis (such as measures of intrusive thoughts, questions about motivation to continue or manipulations of motivation through incentivizing performance, and other measures). Due to the failure of the depletion paradigm, I cannot assess which conditions are the most resource demanding in this study, but the results did illuminate downstream consequences of dealing with emotions in different ways. It seems that trying to regulate emotion in any way is more beneficial to downstream cognitive tasks than just allowing the emotion to continue, but positive reappraisal and distraction are especially beneficial.

In addition to depletion costs, I hoped to explore threat and challenge responses in response to the different regulation instructions. Unfortunately, neither MAP nor TPR demonstrated any effects. Therefore, this hypothesis 7 could also not be evaluated in the current study.

Memory Consequences of Regulation

Memory performance of young and older adults was similarly impacted by each regulation strategy, which is not surprising, given the lack of age differences in emotion regulation success. As expected (hypothesis 5), distraction did impair gist recall, consistent with prior findings (Richards & Gross, 2006). Unexpectedly (hypothesis 5), distraction was also related to marginally higher recognition of peripheral details. Although this was not hypothesized, it seems consistent with a pattern of orienting attention away from the negative aspects of the pictures, as would be expected in successful distraction. Unexpectedly (hypothesis 6), the pattern of results for participants in the detached reappraisal condition was identical to the distraction condition. However, the mechanisms for memory deficits in these two conditions may not be the same. Eyetracking results suggest that people in the distraction condition fixated less on the negative parts of the pictures, relative to those in the other conditions. It is likely that this decreased attention to the pictures is what drives memory effects, as expected. In the detached reappraisal condition, however, participants fixated on negative content to the same extent as participants in the experience condition. Participants in the detached reappraisal group may have successfully reappraised pictures, changing their appraisal of the pictures to be neutral and down-regulating negative emotions (as self-reports suggest). In that case, decreases in gist memory compared to experience could reflect the fact that participants in the detached reappraisal condition are no longer benefiting from the memory boost that often accompanies emotional stimuli.

Decreases in memory associated with detached reappraisal makes theoretical sense, but has not been found in past research. Richards and Gross (2000) used detached reappraisal and found that ability to choose a before-seen slide from a set of similar slides with altered details (based on the examples, the altered details seem like peripheral details as defined in this study) was actually improved by detached reappraisal. Concentrating on memory for detail of the pictures may have biased their results. If just examining memory for detail in the current study, results may have suggested a similar impact of detached reappraisal. They also examined how detached reappraisal influences memory for verbal material that was connected with each picture they presented and found no difference in memory for the verbal information relative to a watch group. This also might be considered peripheral detail. They did not measure gist memory for pictures, however, and therefore could not detect the decrease in gist memory seen in the current study. Contrary to the picture that prior data might suggest, it appears that reappraisal is not always cost-free. It may assist in memory for details, but it can appear to impair memory for overall gist.

Positive reappraisal also appeared to influence memory, but it seems to have improved memory for both age groups, consistent with hypothesis 6. It did not impair memory for gist in the way other regulation strategies did, and it was associated with better recognition memory for both central (emotion-content-related) and peripheral (non-emotional) details. The results suggest that positive reappraisal actually improved memory performance, consistent with the idea that reappraisal allows people to continue processing emotional stimuli. Not only did positive reappraisers appear to continue processing the negative stimuli, they seem to have processed the stimuli in a way that improved memory for all kinds of detail. The dissociation of memory effects in positive and detached reappraisal is a new finding, but it has important implications for future research. Researchers should be careful to recognize that reappraisal is not a unitary construct and different types of reappraisal may have very different practical consequences.

Age Differences in Use of Distraction

Older adults in the distraction condition unexpectedly fixated less on emotional aspects of the pictures than did young adults, although both otherwise evidenced successful (and similar) use of distraction in terms of memory effects and emotional outcomes. Based on these findings, it seems possible that older adults relied on gaze-based distraction (looking towards something less emotional) whereas young adults appeared to visually attend to the stimuli but distract themselves in some other way, possibly by cognitively distracting themselves (e.g. watching the pictures but thinking about something else). This differential use of distraction gives rise to several important questions. First, is one of these types of distraction more effective than the other? For example, it is clear that gaze can be successfully used to regulate emotions in both young and older adults, but I am unaware of any research comparing distraction using gaze to distraction using cognition but not gaze. It is possible that using gaze to prevent the processing of stimuli is simply more effective, as it limits emotion elicitation at the very first possible point in processing. Gross (1998) suggests that the earlier in the process an emotion can be controlled, the easier and more successful the regulation attempt will be. People who continue to view the pictures, but are cognitively distracting themselves, may process the pictures at a somewhat deeper level, and therefore have more difficulty or less success regulating. Without being able to compare these two strategies within age groups, it is difficult to tell whether the strategies may have different outcomes.

Second, why do older and younger adults choose different types of distraction in this situation? On one hand, older adults may choose gaze-based distraction because it is a more efficient way to distract oneself, and they may have more knowledge about how to regulate emotions successfully or more practice choosing successful strategies. On the other hand, older adults may choose gaze-based distraction because it might be easier than cognitive distraction and they may be unable (or less able) to use cognitive distraction in the face of increasing inhibition deficits. Follow-up studies encouraging each of these types of distraction separately might help to determine whether one type of distraction is more effective universally and whether older adults are equally capable of using non-gaze-based distraction.

General Conclusions about Strategies

Unexpectedly, there were no major age differences in findings in this study. If there were age-related liabilities associated with reduced cognitive resources or inhibition deficits, they were not sufficient to cause older adults to struggle with distraction or detached reappraisal. Older adults were equally able to implement both strategies, though their method for implementing distraction may have been somewhat different. Also, there was no evidence for age-related improvement in ability to use positive reappraisal.

However, interesting profiles of costs and benefits emerged for each regulation strategy explored in this study. Distraction and detached reappraisal both were successful in decreasing negative affect and intensity of emotions experienced. They also both impaired memory for gist but helped with memory for peripheral, non-emotional details, relative to memory for participants who allowed themselves to experience their emotions. Distraction, however, had the added benefit of actually improving subsequent task performance. Reappraisal is sometimes touted as a better way to regulate emotions (especially if it is important to maintain memory), but the current study suggests that there may be more benefits to distraction than to detached reappraisal. Positive reappraisal had a rather different profile compared to the other two strategies. Whereas there was some evidence of decrease arousal in older adults and increased valence in young adults, positive reappraisal did not appear to impact level of negative emotion or intensity of emotions. Positive reappraisal was, however, associated with improved memory for both the gist and details of the negative stimuli, and it was associated with improved cognitive performance on a subsequent task.

Depending on a person's goals in a particular situation, these three strategies may be differentially preferable. In a situation where later memory for gist and details of the emotional stimuli is crucial, positive reappraisal appears to be the most effective strategy (even more effective than simply allowing yourself to experience emotions). For example, if person is in a work meeting and the boss criticizes her work, positive reappraisal (perhaps thinking of the criticism as helpful) would allow preserved (or even improved) memory for the arguments made by the boss, which can then be better used to improve performance in the future. Distraction or detached reappraisal might impair memory for the criticism and prevent later improvements based on it. However, in situations where calming oneself is most important, detached reappraisal may be the best strategy, as it influenced valence, negative affect, and intensity of emotion. If your goal is to go do an effortful task, like taking a test, after an emotional episode then using positive reappraisal or distraction may be the best strategy.

Limitations and Future Directions

The failure of many participants to follow exclusively the regulation strategy given to them was a major limitation to this study. Although patterns of results did not appear to be affected by reassigning participants to conditions (though this decreased power and ability to detect significant differences in data patterns), having a mixture of responses within each condition is not optimal. Future researchers might consider having practice periods where participants can view pictures, practice strategies, and receive feedback from experimenters to help shape their behavior before they begin.

The research reported here could also be extended in interesting ways. For example, the study revealed some limited evidence that positive and detached reappraisals did process pictures in different ways, based on later memory for the pictures. In the future, this difference in processing could be measured much more extensively. Eyetracking data, for example, could be analyzed to determine whether positive and detached reappraisers orient to different parts of a scene. For example, some details of the pictures may lend themselves to positive reappraisal and others to detached reappraisal. Positive reappraisers should orient to parts of the picture integral to a positive reappraisal, such as spending time looking at the firefighters in a picture of an unconscious woman being rescued from a burning building. Different memory coding schemes might also help to assess whether positive and detached reappraisal changed participants' memories long-term. For example, in descriptions of pictures, do positive reappraisers use more positive or hopeful words? Do they describe the pictures using a different set of details. A positive reappraiser might mention firefighters *rescuing* an *unconscious* woman, whereas experiencers might describe the same picture as firefighters *carrying* a *dead* woman out of the building. It might also be interesting to see how long these reappraisals last. Are biases in memory more likely to be found if people describe pictures immediately after viewing them? Or do they persist over time?

GENERAL DISCUSSION

Age-related improvements in distraction

Much emotion regulation research has found age-related improvement or lack of age-related changes. Based on prior research, I expected these trends to apply to the emotion regulation strategy of distraction, though some age-related cognitive declines were expected to potentially cause problems with use of distraction in some contexts. The current studies, however, showed minimal age-related improvement in emotion regulation through distraction and were dominated by lack of age-related changes in distraction and a few indicators of age-related decline in distraction.

The few indicators of age-related improvement in emotion regulation were unexpected. First, a positivity effect in memory was found in study 1, though it did not appear to be related to degree of distraction during the recovery period. Instead, it appears to be related to differences in how arousal at encoding impacts memory or attention at encoding (which might reflect attempts to avoid negative stimuli in favor of better emotional outcomes). There was also some limited evidence that older adults may have chosen a more effective form of distraction in study 2, where they used gaze-based distraction to a greater extent than young adults did. There is no clear evidence that use of this type of distraction definitely reflects better strategy selection, but it seems likely that gaze-based distraction eliminates emotional responding earlier in the emotion generation process than other strategies, and this should make it easier and more effective. However, the decision to use this strategy could also reflect age-related declines that make other strategies more difficult to use (Labouvie-vief, Grühn, & Mouras, 2009), and therefore also reflect a decrease in ability to use some types of distraction.

Lack of improvement in use of distraction was unexpected in certain circumstances. Older adults, for example, were expected to dwell less on negative experiences when both groups were allowed to behave spontaneously. As reviewed in the discussion for study 1, this did not occur (see discussion 1 for more details about the possible reasons and implications of this finding). Further, neither study here demonstrated that older adults were more effective at using distraction when both groups were trying to distract nor that distraction was less resource demanding for older adults (though this will be discussed in another section), undermining the idea that distraction may become more effective or automatic for older adults due to practice. Lack of expected improvements, however, does not mean that older adults do not improve at emotion regulation. Instead, improvements may be more confined to other types of strategies or other contexts. For example, the type of stimuli used for negative inductions may create different regulation contexts that motivate participants in different ways or use expertise in different ways. For example, older adults have more tolerance for low-arousal emotions like sadness rather than high-arousal emotions anger, and may be more motivated to distract themselves from anger-inducing situations than from sad ones (Blanchard-Fields, 2007; Consedine et al, 2002). The current study used a mix of stimuli, but the slides were more sadness and disgust oriented than anger-oriented. Consequently, motivations between the age groups may have been more similar than they might be in other contexts.

The majority of findings in the two studies reported here suggest age-related maintenance of ability to use distraction. In study 1 and study 2, emotion-regulation outcomes were not differentiable for the two age groups (in either distraction or reappraisal). Further, memory and cognitive consequences of each strategy in study 2 were the same for older and younger adults. Therefore, distraction appears to be very similarly implemented in older and young adults in both contexts. However, there were some age differences in distraction that might reflect the impact of cognitive decline.

Impact of cognitive decline on use of distraction

The current studies attempted to determine whether cognitive declines in older adults were beneficial or detrimental (or non-consequential) in attempts to use distraction to regulate emotions. The current study found that actual emotion regulation success was not different between older and younger adults, suggesting that whatever differences may exist do not put older adults at either an advantage or disadvantage, in terms of emotional outcomes. However, lack of age-related change in emotional outcome does not mean that cognitive declines did not impact the use of distraction in any way. Several differences in distraction use did emerge, and may indicate some age differences related to cognitive or other changes.

First, older adults did appear to experience some difficulties controlling the degree to which they ruminated about the negative induction after-the-fact. These differences may reflect changes in ability to inhibit previously-but-no-longer-relevant information. Further, older and younger adults appeared to use different types of distraction when regulating online. Whereas older adults used gaze-based distraction, young adults may have used a more cognitive type of distraction. These age differences in use of distraction appear to be consistent with the SAVI model, proposed by Charles (2010). She suggested that older adults tend to excel at using antecedent-focused regulation methods, such as distracting themselves from stimuli very early in the emotion generation process (by avoiding it altogether) but that sometimes older adults have more difficulty regulating emotions if the emotion is already underway. In study 2, older adults appear to be choosing to regulate by avoiding exposure to the information (antecedent-focused distraction), and this leads to outcomes similar to those experienced by young adults, which would be consistent with the SAVI model. In study 1, however, older adults are asked to allow themselves to experience the negative emotions and must try to regulate the emotion after-the-fact. It is here that there was evidence that older adults are having more difficulty controlling their negative thoughts, generally consistent with the suggestion that regulating emotions already underway is difficult for older adults. The SAVI model, however, refers to difficulty in older adults down-regulating strong emotional arousal, such as arousal that might arise during an interpersonal conflict, and suggests that older adults should be able to down-regulate milder emotions, such as those typically used in laboratory inductions. Perhaps the current induction created a stronger emotion than intended, or perhaps the current study provides some evidence that older adults may sometimes be vulnerable even when regulating in relatively mild situations. These results are all tentative, however, because older adults did experience similar emotion regulation success, even if there was other evidence for differences in use of distraction.

Cognitive requirements of distraction

The current study had mixed success in examining the cognitive requirements of distraction. Study 1, examining distraction in a recovery paradigm, provided evidence that distraction was not related to cognitive resources (in SEM analysis), but also provided some evidence that older adults' inhibition deficits might make it more difficult for them to control negative thoughts, compared to young adults. In study 2, examining online distraction, older adults are not less able to use distraction, despite their reduced resources, but this may have been due to 1) their willingness to devote greater resources to success or 2) their selection of a different type of distraction strategy (gaze-based). This seems to suggest that if online distraction requires cognitive resources, the resources are not so substantial that older adults cannot overcome their deficits. Because the depletion paradigm failed, more specific understanding of resources devoted to distraction is not possible. However, there is no evidence supporting the possibility that decreased resources may 1) benefit older adults by making them more distractible in the face of a distractor task or 2) that older adults require fewer resources to use distraction in any context (though it is still possible they require less resources in an online situation). Instead, it seems more likely that age-related changes in cognition are, at best, not a liability for older adults because distraction may not be related to resources (as in SEM in study 1) or that older adults are able to successfully compensate even if distraction requires resources (as may occur in study 2). At worst, it seems possible that reduced resources are a liability for older adults, who struggle to control their negative thoughts more than young adults in study 1, and this may be especially true in a recovery paradigm. Future research will have to further investigate the question of resource requirements for distraction, relying on paradigms other than the depletion paradigm. Future research may also benefit by varying strength of emotion induction to see if stronger inductions (which should require greater resource needs if distraction is resource demanding) elicit greater age differences.

Defining distraction

One important issue discussed in the introduction was the variability in definitions of distraction available in the literature. The current studies suggest important thinking points for researchers trying to understand and define the nature of distraction.

Distraction is not unitary. First, it does appear that distraction may not be one unified process, but instead may be better thought of as an umbrella term that can vary in specifics based on context, in the same way that reappraisal can be split into detached and positive reappraisal. I would suggest that the basic common process behind all forms of distraction is the reorienting of attention away from one stimulus or type of thought onto another, such as replacing thoughts about an argument with thoughts about tasks to be done later in the day. However, the specifics of *how* a person reorients thoughts can vary, which could be glimpsed in the two studies reported here. In study 2, where online distraction was being used, older and younger adults appeared to use slightly different strategies to distract themselves from the negative pictures. Older adults appeared to rely more on gaze to avoid processing the negative stimuli, whereas young adults appeared to visually attend more to the pictures but still evidenced successful distraction in other variables. In study 1, where participants were distracting themselves after the emotions were already elicited, gaze orientation obviously is not a useful form of distraction, as the to-be-avoided information is comprised of internal thoughts. In that case, participants must use a form of distraction that creates new ideas that will take attentional resources away from ongoing negative thoughts. This form of distraction may be more similar to whatever cognitive distraction young adults use during the online regulation task in study 2. Further, distraction does not have to be something controlled by the individual. In the FAS condition in study 1, participants were successfully distracted by having another task to do. This perhaps required very little self-initiative and may be more effective for some participants who do not self-distract effectively (perhaps because they naturally choose less successful distraction topics or use suppression instead of distraction). Another type of distraction, not examined in the current studies, is positive refocusing, used by Phillips et al (2008). Participants who direct their thoughts to alternative ideas might direct those thoughts to different types of ideas—such as positive experiences or future goals.

It is likely that sub-types of distraction have different costs and benefits which should be further explored in future research. For example, if older adults have particular difficulty orienting away from emotional stimuli, having them orient towards alternative emotional stimuli might be more effective than asking them to orient towards something that is emotionally neutral (and therefore less salient). If that is the case, then positive refocusing, rather than focusing on a future goal or another topic, might be more effective for older adults especially. Phillips et al (2008) found age-related improvement in use of distraction in their study using positive refocusing, but the current study failed to find age differences in use of distraction, where participants were left to devise their own distraction strategies. Further, there may be differences in efficacy of distraction strategies depending on how early in the emotion generation process they occur (consistent with Gross, 1997). Gaze-focused distraction may be especially effective because it works so early in the process of emotion generation, and may require less effort than more cognitively-based strategies. The current study cannot assess the differences in these strategies, but older adults, who have reduced resources, did favor gaze-based strategies in study 2. As mentioned previously, future research should examine whether one of these distraction styles is more effective or effortful. As expected, there is also potential difference in outcome based on whether distraction is antecedent or after-the-fact. I found greater age differences in ability to control negative thoughts in after-the-fact regulation in study 1 than in online regulation in study 2. This might be due to the fact that participants in study 1 were dealing with emotions that were already underway, and therefore harder to distract from, though it is important to note there are many differences in the two paradigms that preclude direct comparisons of the two studies.

The relationship of distraction to other constructs. Second, another important consideration in defining distraction as a concept is finding the boundaries for distraction and other related concepts, such as suppression, and learning how these concepts interact during emotion regulation attempts. Study 1 highlights the importance of teasing apart suppression and distraction, as participants seemed to spontaneously choose both of these strategies when trying to recover from the emotion induction. These two strategies are often conceptualized as very similar, but suppression may have some unfortunate consequences, such as thought rebound, that might prolong negative emotional outcomes. Experimentally differentiating these two strategies might be somewhat difficult in a recovery paradigm, as both should be characterized by reduced thoughts about negative stimuli and emotions. However, it is possible that the thought processes associated with suppression are less goal-oriented than those associated with suppression, as discussed in the first discussion section. People who distract themselves should limit thoughts by specifically seeking out other types of thoughts, whereas those who suppress thoughts might mindwander in a less directed way.

The delineation of rumination and distraction can also be difficult to determine, but it is theoretically important, especially in a recovery paradigm. Specifically, the absence of rumination does not necessarily indicate distraction (or even suppression), though it is often interpreted that way in the literature. For example, in study 1, it is difficult to determine whether low levels of rumination after the induction are the product of 1) distraction or suppression that limits negative thoughts or 2) natural dissipation of negative thoughts as time progresses. However, some evidence from study 1 does suggest that distraction takes place. For example, in the uninstructed SOC condition, there is more evidence of rumination than in the other two conditions, suggesting that at least some rumination would occur if distraction or suppression did not take place.

Intentionality of distraction. Third, researchers examining the construct of distraction should consider how intentional distraction must be. Study 1 demonstrates that distraction can take place without intention, in that people can be distracted by ongoing tasks despite not purposefully engaging in emotion regulation. However, other results were mixed. When comparing different groups of participants, there were no patterns to suggest that certain groups regulated more automatically than others, but a lack of correlation between ratings of intentional distraction and actual evidence of distraction could indicate that some participants were regulating automatically whereas others were not. It seems likely to me that some participants engage in automatic forms of distraction—by selecting alternative thoughts to focus on, rather than focusing on negative stimuli they are encountering or negative thoughts that are lingering. However, this does not appear to be related to age in the current study, as would be expected based on age-related practice. Instead, automatically instigated distraction may be the result of other factors, which can vary within age group, such as general emotion regulation goals (or personality factors) that prime people to behave in a goal-consistent manner. Older adults may not demonstrate evidence of greater automaticity of use of distraction because 1) distraction may become relatively automatic for many young adults as well (it may not require a lifetime of experience to become a default method of coping) or 2) older adults may rely on other strategies to a greater extent and therefore not improve in distraction with age (though, if they do, reappraisal did not evidence being more relied-upon in study 1).

Conclusion

Some age-related changes in use of distraction emerged in the current study: older adults selected a different type of distraction during online regulation, demonstrated a positivity effect during the recovery paradigm that might be the result of arousal or motivation at encoding, and had more difficulty ignoring negative thoughts in a recovery paradigm). Age differences appeared to be larger in the recovery paradigm, where participants were regulating after-the-fact, which is consistent with the SAVI model and with Gross's modal model of emotion regulation, which suggests that regulation is more difficult the later it occurs in the emotion generation process. However, the majority of results in the study were marked by lack of age differences, suggesting that older adults neither reap great benefits from changes in motivation, practice, or cognitive changes, but also do not experience major liabilities in emotion regulation associated with these factors.

The study also demonstrated the pros and cons of different regulation strategies, which appeared to be the same for both age groups. If recovering from a negative emotional experience, specific distractor tasks appear to best limit negative thoughts and improve negative affect. In regulating online, distraction, detached reappraisal, and positive reappraisal each have their own profile of consequences, which may be more or less beneficial depending on a person's situation and goals.

Based on the limitations of the current research, three questions seem to be of most interest in trying to better understand the use of distraction (and how it might differ between age groups). First, future research should carefully tease apart and examine the pros and cons of distraction as compared to suppression. There may be age differences in which strategy is selected and in the consequences of suppression that might help shed further light on age-differences in emotion regulation. Second, the cognitive costs of distraction need to be examined further, probably with different paradigms than the ones used here (especially the depletion paradigm). There may still be age differences in resources that must be allotted to distraction (and reappraisal), but I was unable to examine them carefully here and obtained some mixed results. However, if age differences do emerge, it would give us a clearer picture of where age differences in successful regulation might emerge. And finally, implications of the various forms of distraction should be further explored and compared across age groups (such as comparing positive refocusing and goal-oriented distraction or gaze-based distraction and cognitive distraction). Implications of these particular variations of distraction were not well-controlled in this study.

APPENDIX A

Cognitive Task Scoring and Cleaning

In general, if a participants' performance was at or below chance on a measure, then the measure was not used for that participant.

Stroop Task

Experimenters hand recorded Stroop accuracy and microphone errors. Reaction times for inaccurate trials and trials with microphone errors were removed. Trials where a microphone error occurred were also removed from accuracy analysis, as participants often did not have time to make a response before the computer moved to the next item. RT and accuracy were then calculated separately for each trial type (congruent, incongruent, and neutral). A RT difference score was calculated by subtracting the mean RT for the neutral trials from the mean RT of the incongruent trials.

The accuracy variables were negatively skewed (skewness = -5.577, -2.239, -2.635, respectively), which often happens when accuracy is high. To reduce skewness, the accuracy variables were transformed by taking z-scores corresponding to the cumulative probability of the accuracy score. The accuracy score in the incongruent condition, the variable of interest, had a skewness of -.587 after the transformation, which is considered within acceptable range.

Flanker Task

The flanker task data was separated into compatible, incompatible, and no noise conditions. Reaction times for inaccurate trials were removed, and then any RT more than 2.5 standard deviations from a participants' mean on each trial type was removed as an outlier. RT means and percent accuracy was then calculated for each trial type. An RT difference score was calculated by subtracting the RT in the no noise condition from the RT in the incompatible condition. The RT difference scores and the accuracy scores for the incompatible trial were skewed (2.146, -3.027, respectively). To reduce skewness in the RT variable, scores were log transformed to put less weight on the outliers on the right end of the distribution (who were unusually slow). Skewed accuracy was handled in the same way as for the Stroop task. Skewness for both variables was reduced after transformation (RT: .130, Accuracy: 2.146).

Anti-saccade Task

After removing data for participants with accuracy below chance, there was a lot more missing data for older than for young adults. Many older adults did not finish the task because they could not see the probes, and others finished the task but performed very poorly. It appears that the probes were too quick for older adults to see, so performance on this task is unlikely to reflect selective attention in older adults. It was not used in further analysis for this reason.

Visual Arrays

For visual arrays, the accuracy variable was the variable of interest because it has been demonstrated to be related to availability in working memory and related to other kinds of cognition, and therefore seems more likely to be related to other concepts in the current study. For each individual a percent accuracy was calculated for visual array set sizes 4, 6, and 8 separately. Then, these percents were z-score transformed and averaged together to create a visual accuracy composite score.

N-back

N-back trials from session 1 were used (these were meant to be a baseline in study 2). The N-back reaction times were trimmed to remove RTs for inaccurate trials. In addition, anything outside 2.5 standard deviations from a participants' own mean (on a particular N-back version) was removed as an outlier. RTs were then averaged separately for each N-back version for each participant. Accuracy was calculated as percent correct for each N-back version for each participant separately.

N-back accuracy was chosen as the more important variable for use in the current analysis because RTs can become increasingly less reliable as the N-back version becomes more difficult and more inaccurate trial RTs must be removed, making accuracy a more reliable indicator. N-back accuracy for the 3, 4, and 5-back were used because they are more likely to reflect working memory than a 1 or 2 back. Accuracy scores were z-transformed and then each participant's z-scores for the 3 N-backs were averaged to reach an N-back accuracy composite score, for use in analysis.

Other cognitive variables

Vocabulary, pattern comparison, letter comparison, and R-Span did not require any cleaning or adjustment for skewness. They were calculated in the typical method.

APPENDIX B

Picture Selection Process

Emotion pictures were selected based on several criteria. First, to the extent it was possible, pictures were selected based on being age-invariant on valence in Grühn & Scheibe's (2008) study comparing older and younger adults. The selection of pictures in that study was limited, however, so some pictures were based on being thematically similar to pictures that were age invariant in the norming study and having highly negative valence scores in the original IAPS norming study (Lang, Bradley, & Cuthbert, 2005). Second, pictures were selected looking at our own original pilot data, which suggested that pictures of violence were more successful at eliciting physiological reactivity. Third, another set of piloting comparing young adults from the Georgia Tech population, young adults from the community, and older adults was conducted to see if slides elicited appropriate physiological arousal of similar levels in all groups. Physiological reactivity did not appear to be significantly different in young and older adults. Fourth, slides were selected based on creating a thematically similar pair with similar valence ratings in the norming samples (one for study 1, one for study 2). For example, one pair was fear-inducing animals (spider/snake). Finally, I selected slides based on whether they were likely to be confused with other slides in the set. Because memory for the slides was tested in the second study, I wanted to minimize the degree to which participants would have difficulty telling the slides apart or describing the slides in ways that the experimenter could easily differentiate them based on participants' descriptions.

A benefit to pictures is that they present repeated opportunities to regulate, which we expected to increase regulatory load relative to a film clip. For example, when watching a film clip, a participant can reappraise early on and this should help them to minimize emotional reaction for the rest of the clip. With presentation of a new picture every 15 seconds, just reappraising once early on will not be sufficient, as participants would have to come up with a new reappraisal for each picture. Likewise, in the case of distraction, as new stimuli are presented that may grab the participants' attention, the participant will have to resist this tendency and continue distracting themselves. Therefore, it appears that a series of pictures provides us with the most opportunity to find regulation costs, if they exist for a particular strategy.

APPENDIX C

Other Physiology Outcomes in Study 1

PEP

There was a significant interaction of sex and condition $F(2, 166) = 4.352$, $p < .05$, partial eta squared = .05, with females in the FAS condition having lower PEP than males, females in the instructed SOC condition having equivalent PEP compared to males, and females in the uninstructed SOC condition having lower PEP than males in the same condition. Given that this interaction does not involve time or trial type, it most likely reflects a failure of random assignment.

The analyses also found a significant time X condition effect $F(2, 166) = 4.939$, $p < .01$, partial eta squared = .056. In addition, within the FAS and instructed SOC condition, there was no significant change from baseline to trial in PEP, but in the uninstructed SOC condition, there was a significant decrease in PEP from baseline to trial.

TPR

The omnibus ANOVA revealed a significant main effect of trial type $F(1, 169) = 5.214$, $p < .05$, partial eta squared = .032, such that participants had lower TPR in the neutral condition relative to the negative condition, but trial type did not interact with time, so there is no evidence of induction. There was also a significant main effect of age group $F(1, 158) = 22.889$, $p < .001$, partial eta squared = .127, with OAs exhibiting higher TPR.

EDA

The omnibus ANOVA revealed a significant main effect of age $F(1, 185) = 67.852$, $p < .001$, partial eta squared = .268, such that OAs had lower TSCL overall.

There was also a significant main effect of time $F(1, 185) = 12.885$, $p < .001$, partial eta squared = .065, with participants having higher TSCL in the baseline than in the trial (it is common to see SCL drop as people acclimate to the study).

APPENDIX D

Analysis of Other Mindwandering Variables

The same planned analyses conducted for the negative mindwandering probes were also conducted for the other two variables, including follow-up planned comparisons.

Retrospective count. Analyses using retrospective mindwandering count demonstrated no significant main effect of age or an interaction effect, but did reveal a significant main effect of recovery condition, $F(2, 200) = 8.414$, $p < .001$, partial eta squared = .078. Follow-up 2 (condition) X 2 (age group) ANOVAs comparing each set of conditions were conducted, due to a prior hypotheses. Retrospective mindwandering count was significantly higher in the uninstructed SOC condition than the FAS condition $F(1, 134) = 15.303$, $p < .001$, partial eta squared = .102. Retrospective count was marginally higher in the uninstructed SOC condition compared to the instructed SOC condition $F(1, 131) = 3.641$, $p = .059$, partial eta squared = .027. Retrospective count was also higher in the instructed SOC condition than in the FAS condition $F(1, 135) = 4.673$, $p < .05$, partial eta squared = .033, but this was qualified by a marginally significant age group X condition effect $F(1, 135) = 3.670$, $p = .058$, partial eta squared = .026, such that young adults' ratings did not differ between the FAS and instructed SOC condition, but older adults reported significantly greater negative mindwandering in the instructed SOC condition. There were no other effects. Comparisons of age groups within each condition revealed no significant differences in the two SOC conditions, but a marginally significant difference in the FAS condition $F(1, 69) = 23.373$, $p = .063$, partial eta squared = .049, such that older adults reported less mindwandering.

This version of results would suggest that 1) people benefited from the FAS condition, but older adults may have benefited slightly more (unlike in probe results), 2) people regulated more when asked to do so, relative to when they were left to spontaneous strategy use (consistent with probe results), and 3) older adults did not appear to either spontaneously self-distract more than young adults or more effectively self-distract when both groups were trying to regulate (consistent with probe results), but at least did not demonstrate less self-distraction than young adults (inconsistent with probe results).

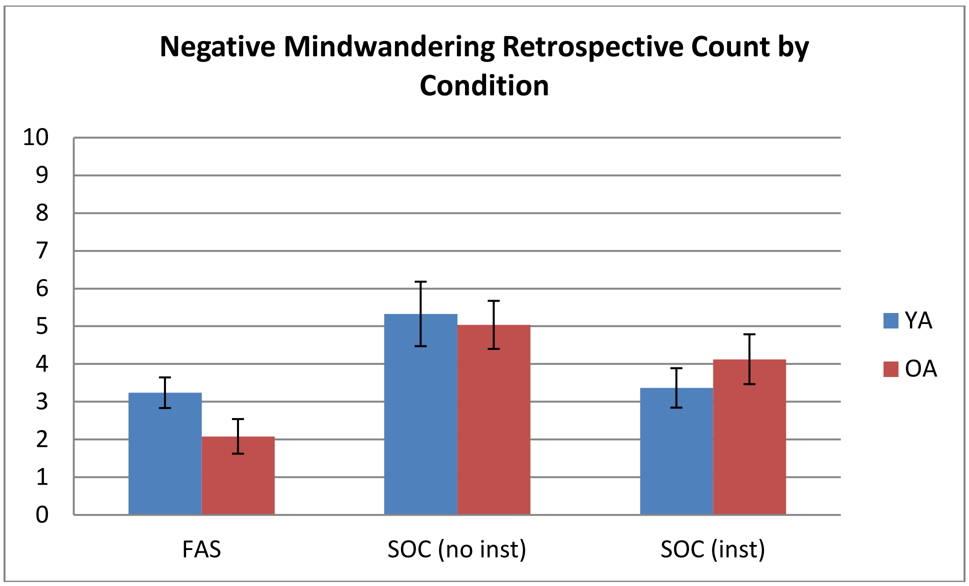

Figure 28. Negative mindwandering retrospective count by condition.

Comparing retrospective and online mindwandering reports. Further inspection of the retrospective and online mindwandering reports seems to suggest that, whereas older adults report similar levels of mindwandering using both metrics, young adults report higher levels of mindwandering when using retrospective reporting. To examine this, I conducted a post hoc analysis comparing retrospective and online reports in a 2 (report type) X 2 (age group) X 3 (condition) repeated measures analysis, with report type as the within subjects variable. There was no significant main effect of report type, but there was a significant report type X age interaction effect, F (1, 196) = 10.956, partial eta squared = .053. Separate ANOVAs within each age group demonstrate no main effect of report type for older adults, but a significant effect of report type for young adults $F(1, 111) = 13.284$, $p < .001$, partial eta squared = .107, with retrospective negative mindwandering estimates being higher than online estimates for young adults. I also conducted correlations between negative mindwandering as measured by probes and retrospectively (separately for each age group). The correlation for young adults was .75 ($p < .001$) and for older adults was .77 ($p < .001$), suggesting that the correlation between the two measures was somewhat higher in older adults, though the two correlations did not differ significantly.

Retrospective time estimate. Analyses using retrospective time estimates of negative mindwandering demonstrated a significant main effect of condition $F(1, 201) = 4.713$, $p < .01$, partial eta squared = .045. But neither significant main effect of age group nor an interaction effect emerged. When comparing the FAS to uninstructed SOC conditions, a main effect of condition emerged $F(1, 135) = 8.952$, $p < .005$, partial eta squared = .062, which was qualified by an age group X condition effect $F(1, 135) = 3.531$, $p = .062$, partial eta squared = .025. The difference between retrospective time estimates in older adults was greater than in young adults, with mindwandering being greater in the uninstructed SOC condition.

When comparing the two SOC conditions, no significant main effect of condition emerged. A t-test comparing the two age groups in the FAS condition confirmed that older adults reported spending significantly less time mindwandering about the negative pictures $t(69) = 2.429$, $p < .05$. These results are largely consistent with the retrospective count results, and probably influenced by similar factors. There was no significant difference in the two SOC conditions. There was a significant effect of condition when comparing the instructed SOC and FAS conditions $F(1, 136) = 6.342$, $p < .05$, partial eta squared = .015, such that mindwandering was higher in the instructed SOC condition.

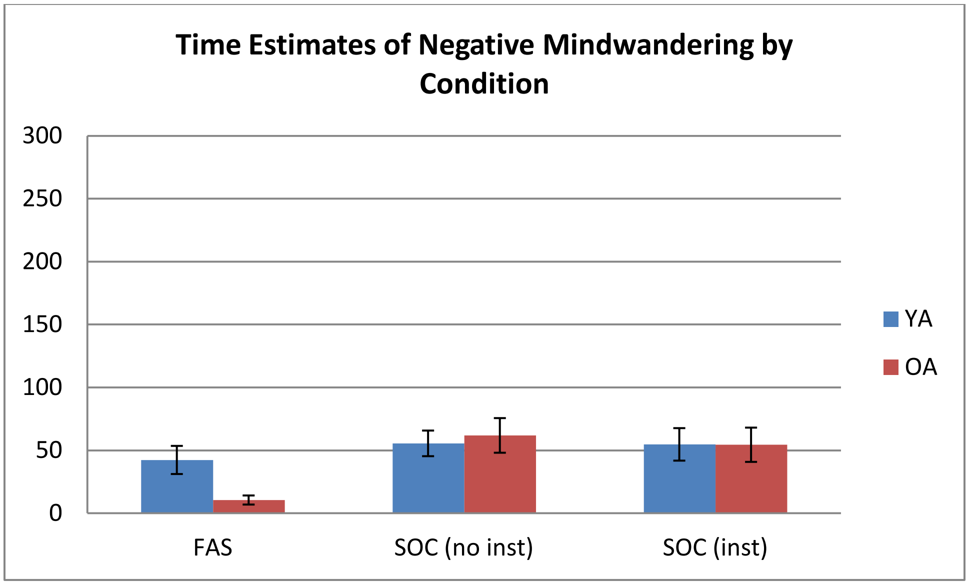

Figure 29. Retrospective time estimates of negative mindwandering by condition.

APPENDIX E

Coding of SOC Writings

The strategies reflected in the SOC writings were coded by two independent coders (as done by Denson, 2011). In each case, coders rated independently and then discussed until consensus was reached, which occurred in all but two cases. In the two cases where consensus was not reached, an average of the two scores was taken and used as the score for those participants under the appropriate strategy. Scores ranged from 0 to 4 and were based on the percentage of the participants' writing that used the strategy. A score of 0 meant that the strategy was not used at all, whereas a score of 4 meant that the strategy was the only strategy used. A score of 2 meant that the strategy took up half of the writing. Three participants could not be coded because their writings were too unclear.

APPENDIX F

Memory Coding Process

Coding of regulation strategies. Definitions of each of these behaviors were derived from the descriptions given to participants in the corresponding conditions (see above), and specific examples were added to the coding scheme as the coders encountered items that did not clearly fit into the original definition but were believed to reflect the same process. Two coders coded each of the participants' responses. For each of the categories, each participant was coded as either using or not using that strategy. To be coded as using a strategy, a participant had to mention thoughts consistent with that strategy description at least once. Participants could be coded as using more than one strategy.

Data on this variable was only available for 197 participants, due to problem with the voice recorder early in data collection. The coders' use of the categories was highly consistent. When rating the presence or absence of each strategy category, coders agreed 93.9% of the time for positive reappraisal, 88.3% of the time for detached reappraisal, 88.8% of the time for distraction, and 94.4% of the time for experience (total absence of regulation). Twelve participants' responses were categorized as being uncodable, typically because they were too vague to be fit into a category. Three participants' responses did not fit into the other categories, but were clearly attempts to regulate emotions (such as trying to breathe in and out in a calming manner). In cases where the two coders' initial categorizations were inconsistent, the participant's response was discussed until consensus was reached. Consensus was reached in all cases.

Grouping based on coding. For further (unreported) analyses, participants were split into groups based on several criteria. First, if participants only reported using one type of emotion regulation strategy, they were assigned to that condition for analyses. If data was missing for a participant or the participant's data was uncodable, then the participant was included in analyses for the group that they were assigned to originally (so, people assigned to positive reappraisal who did not have codable data were placed in the positive reappraisal group for analyses). Finally, there was a substantial group of people who used some combination of strategies. There were not sufficiently large groups of people using each combination, so instead a group was formed that included anyone who used multiple strategies. This scheme for assigning participants left some cells relatively sparse, but was the most theoretically defensible.

APPENDIX G

Other Physiology Results in Study 2

PEP

The omnibus ANOVA revealed a significant main effect of regulation instruction $F(3, 164) = 2.852$, $p < .05$. There was also a main effect of trial type $F(1, 164) = 13.44$, $p < .001$, partial eta squared = .076. Both of these main effects were qualified by interaction effects. A trial type X age group interaction effect emerged $F(1, 164) = 5.982$, $p < .05$. These effects were qualified by the four way interaction reported in the body of the paper.

IBI

There was also a main effect of age group $F(1, 174) = 4.546$, $p < .05$, partial eta squared = .025, with older adults having longer IBIs in general. A main effect of trial type $F(1, 174) = 14.788$, $p < .001$, partial eta squared = .078, such that IBI was higher in the regulate epoch, but since this is not qualified by a time X trial type effect, it does not reflect emotion induction. It likely reflects habituation to the study or other changes driven by general participation in the study procedures.

TPR

The omnibus ANOVA showed a significant effect of trial type $F(1, 155) = 23.573$, $p < .001$, partial eta square = .132, with TPR higher in the regulate epoch compared to the watch epoch, but this did not interact with time and therefore does not suggest regulation. There was also a significant main effect of age group $F(1, 155) = 25.812$, $p < .001$, partial eta squared = .143, such that older adults displayed higher TPR overall.

MAP

The omnibus ANOVA revealed a main effect of age $F(1, 158) = 16.184$, $p < .001$, partial eta square = .093, with older adults have higher MAP. A main effect of time also emerged $F(1, 158) = 7.523$, $p < .01$, partial eta squared = .045, with MAP decreasing from baseline to trial.

EDA

There was a main effect of age group $F(1, 184) = 70.337$, $p < .001$, partial eta squared = .277, with older adults having lower TSCL. There was also a significant main effect of trial type $F(1, 184) = 85.906$, $p < .001$, partial eta squared = .318, with participants having higher TSCL in the watch trial relative to the regulate trial, which may reflect participants acclimating to study participation.

RSA

There was a significant main effect of age group $F (1, 169) = 63.786$, $p < .001$, partial eta squared = .274, such that OAs have lower RSA.

APPENDIX H

Memory Coding Process

Reasoning behind variable selection. In this study, both gist and detail memory for the pictures were measured. Gist memory, memory for the basic meaning of a stimulus, is improved by emotional arousal (Reisberg & Heuer, 2004). Further, details of negative emotional events are remembered better than details of other events (Kensinger, 2009), though peripheral details (like details of a picture that are not important to the emotional event, such as background elements) are not well remembered (Payne et al, 2006). Both gist and detail are included because it is not clear how different conditions might impact gist and detail memory differently. For example, distraction could impair memory for specific details but not for general gist. If participants do even minimal processing of a particular picture, they may later remember the gist, even if they were able to largely ignore the picture. However, this same participant may demonstrate lower memory for details compared to people who attended to the picture more closely. If I just measured gist, participants who did minimal processing of a picture may have appeared to have similar memory levels as those who did more processing. By including measures of memory for detail, I reduced the likelihood that this will be an issue. Further, including both gist and detail was important because older adults may remember primarily gist with little detail, but young adults may remember more details. Collecting data about both types of memory increased the likelihood that I would be able to detect differences between conditions within each age group in at least one of the measures.

In addition, a follow-up forced-choice recognition test asked participants questions about central and peripheral details of each picture. A recognition test was included because older adults sometimes have difficulty with free recall and may have very low hit rates, which would limit the ability to detect differences between conditions.

Recognition tends to be better spared with age, and may provide evidence of condition differences in the absence of condition differences in the free recall portion.

Recall coding. Gist was measured by allowing participants to free recall as much as they could remember about as many pictures as possible. Coders rated whether each picture's gist was recounted (0 = not present, 1 = present). Acceptable gist for each picture was included in the coding scheme in a document provided to all coders and updated as problems arose. Gist was only coded as described if the description of the picture was clearly related to a specific picture in the set (general statements like "a violent man" were not sufficient because multiple pictures included this gist). To complement gist information, coders also coded for number of accurate and false details for each picture included in the description. Details were considered accurate if a person curently viewing the picture would be likely to identify the detail in the way the participant described it. For example, there is a picture of someone carrying a severed animal head. It was not clear what type of animal was being carried other than that it had a horn and was deer-like. Any deer-like animal was accepted as accurate detail. The coders made and updated a list with details that were considered acceptable for each picture.

There were three coders involved in recall coding. Coders 1 and 2 both coded 32 of the same participants' responses. For these responses, the coders compared all data and came to agreements on items that were coded differently. Coders 1 and 3 coded 37 of the same participants' responses and came to agreements on items that were coded differently. The remaining participants were either coded by coder 1 or coder 3, with weekly meetings to compare items both coders had coded to make sure coding consistency was being maintained. For items that were coded by two coders, the coding reached through consensus were used. For items coded by only one coder, that person's coding as used. The ICCs (absolute agreement) were acceptable for coders 1 and 3 (Gist:.875, Detail: .833, False Detail: .584). ICCs (absolute agreement) for coders 1 and 2 was similar (Gist: .870, Detail: .867, False Detail: .512).

Codings were done for each picture for each participant. Then, for each study, gist was calculated for each participant by counting the number of picture gists they described. Detail and false detail were calculated by calculating the average number of details that each participant described per picture whose gist they described.

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